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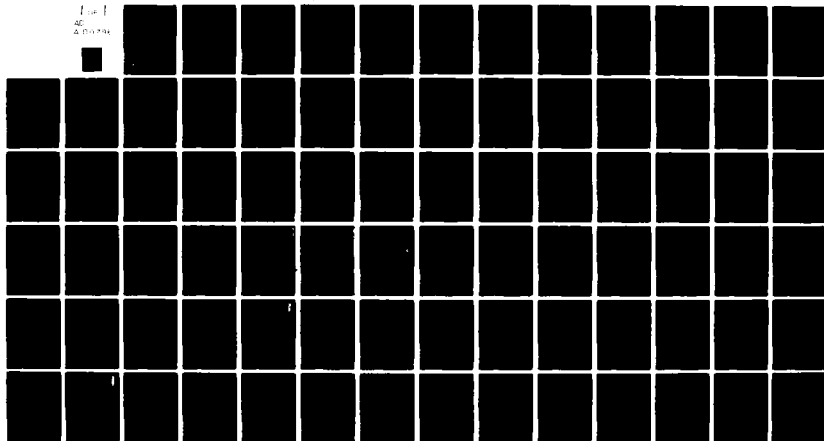
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REPORT

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OCEANOGRAPHIC OBSERVATIONS IN THE INDIAN OCEAN, MARCH 1978

A CHEMICAL SURVEY BY MARINE ENVIRONMENT GROUP

Russell W. Pettis and Daniel J. Whelan

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Chemical and physicochemical data on water samples taken at depths down to 4000 metres from eleven stations in the South-East Indian Ocean in March 1978 have been compiled.

Samples from each station were analysed for variations with depth of temperature, salinity, pH and alkalinity, dissolved oxygen, metal ions and nutrients. From this material, comments have been made about certain parameters in sea water which may have long-term operational significance, viz. sound speed at various depths, the location of the deep ocean sound channel axis, the absorption of sound in sea water and the nature of the chemical environment at these stations.

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Chemical and physicochemical data on water samples taken at depths down to 4000 metres from eleven stations in the South-East Indian Ocean in March 1978 have been compiled.

Samples from each station were analysed for variations with depth of temperature, salinity, pH and alkalinity, dissolved oxygen, metal ions and nutrients. From this material, comments have been made about certain parameters in sea water which may have long-term operational significance, viz. sound speed at various depths, the location of the deep ocean sound channel axis, the absorption of sound in sea water and the nature of the chemical environment at these stations.

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OCEANOGRAPHIC OBSERVATIONS IN THE INDIAN OCEAN, MARCH 1978

A CHEMICAL SURVEY BY MARINE ENVIRONMENT GROUP

1. INTRODUCTION

This is a preliminary report, prepared solely to document the scientific data arising from the MRL Cruise OP7803 on board HMAS Diamantina in the Indian Ocean (February-March 1978).

No attempt has been made to analyse these data in detail in this report as this will be the subject of further publications from these laboratories, but the compilation has been scrutinized in detail and some general observations made.

2. CRUISE PROGRAMME AND OBJECTIVES

The cruise programme involved a transect of the Indian Ocean from Fremantle to the Sunda Trench, proceeding north along meridian 105°E and returning to Fremantle, proceeding south along meridian 112°E (Table 1 and Figures 1 and 2).

In this cruise, eleven stations were visited and, at each station, an extensive water sampling programme (Table 2) was carried out. A series of chemical analyses was then performed on board ship and concluded back at MRL.

The aim of this cruise was to characterise the oceanic waters of part of the Indian Ocean in terms of various chemical constituents, some of which may relate to phenomena having long-term operational significance; these include the velocity of sound in sea water [1,2], low frequency and intermediate frequency sound absorption in sea water [3,4], sound reverberation [5] and transmission [6].

Samples from each station have been analysed for variations with depth of

- (i) temperature
- (ii) salinity
- (iii) pH and alkalinity
- (iv) dissolved oxygen
- (v) magnesium and boron concentrations
- (vi) trace metals, and
- (vii) nutrients.

At shallower stations, sediment cores were taken and have been characterised by chemical techniques [7].

3. METHOD OF COLLECTION AND ANALYSIS OF SAMPLES

All water samples were collected in 5 litre PVC Niskin bottles fitted with reversing thermometer frames. The bottles were deployed at suitable internationally accepted standard depths recommended by the United States Navy Oceanographic Manual, No. 607, on a steel hydrographic wire [8].

3.1 Temperature

Water temperatures were taken with deep sea reversing thermometers, both protected thermometers (with a range of -2° to 30°C) and unprotected thermometers (with ranges of either -2° to 30°C , or -4° to 60°C) being used. The accuracy of the temperature measurements has been quoted to be within the range $\pm 0.03^{\circ}\text{C}$.

3.2 Thermometric Depth

Depths were calculated from temperature measurements by the method described by Pollack [9] using computer programs written at MRL. These thermometric depths were considered to be accurate to within 1% at depths down to 1000 m and to within ± 15 m at depths greater than 1000 m. They were refined by graphical techniques, plotting wire length as a function of thermometric depth to give the accepted depth at which the sample was taken.

3.3 Salinity

Salinity was measured with an Autolab Inductive Salinometer, Model 601 Mark III [10]. Salinity is recorded in units of grams of solid material per kilogram solution or parts per thousand, by weight.

3.4 Dissolved Oxygen

The modified Winkler method described by Strickland and Parsons, was used with potassium iodate as the iodometric standard [11,12,13]. Samples were collected in 275-300 ml capacity bottles and were titrated to a starch end point. Values are given as mg/l solution.

3.5 Chlorinity

Chlorinity was calculated from the salinity data, using the formula

$$S \text{ (ppt)} = 1.80655 \times Cl \text{ (ppt)}$$

recommended by the UNESCO Joint Panel on the Equation of State of Sea Water [14,15].

3.6 pH and Total Alkalinity

The Anderson and Robinson method was used to determine alkalinity [16].

pH measurements were carried out using a digital Radiometer pH meter with a combination glass electrode.

All samples (150 ml) were collected in polyethylene bottles that were soaked in 1% hydrochloric acid and then rinsed thoroughly in distilled water before they were dried. Total alkalinity values are reported as milli-equivalents per litre.

3.7 Magnesium

Samples were collected in 500 ml glass bottles and analysed by atomic absorption spectrophotometry [17]. Magnesium values are reported as mg/l or parts per million. The value reported is the mean of ten replicate analyses.

3.8 Boron

Samples were collected in 100 ml polyethylene bottles and preserved with 1 ml of 5% $HgCl_2$ solution. Boron was determined at MRL by the automated curcumin method [18], the value reported being the mean of six replicate analysis. The boron value is reported in mg/l or parts per million.

3.9 Trace Heavy Metals

Samples were collected in 1 litre polyethylene bottles and acidified to pH 1.5 with BDH suprapur nitric acid. Copper, lead, cadmium and zinc were determined by anodic stripping voltammetry [19] on board ship and selected samples reanalysed in the laboratory. The values are reported in units of $\mu g/l$ or parts per billion.

3.10 Nutrients

After collection, the water samples were stored in plastic bags (Whirlpaks) at -20° , transferred to MRL and subsequently analysed.

All nutrients were determined at MRL employing automatic procedures using a Chemilab Auto Analyser, Model 1977 [20].

The procedures adopted for these analyses followed that described in the three standard reference books [8,11,13] used in our work.

3.10.1 Nitrate/Nitrite

Nitrate/nitrite was determined at MRL by a modification of the method of Armstrong [21].

In the first instance, a sample of the sea water is analysed for nitrite, which reacts with sulphanilamide under acidic conditions to form a diazo compound. This diazo compound then couples with N-(1-naphthyl)-ethylenediamine dihydrochloride to yield a reddish-brown azo dye, which can be monitored spectrophotometrically.

A second sample is then analysed for nitrate/nitrite by first reducing nitrate to nitrite on a cadmium-copper reactor column and then analysing for total nitrite, as above.

The concentration of nitrate represents the difference in these two analyses.

3.10.2 Silicate

In this determination, silicate was converted to silicomolybdate in acid solution and then reduced to a "molybdenum blue" by ascorbic acid [22]; phosphate interference is eliminated by the addition of oxalic acid to the sample stream of the autoanalyser before the addition of ascorbic acid.

3.10.3 Orthophosphate

In this method, orthophosphate complexed with ammonium molybdate to form the well-known phosphomolybdenum blue complex [23], which was monitored at 880 nm.

3.10.4 Ammonia

Ammonia was determined by the Berthelot Reaction, in which a blue coloured compound, believed to be closely related to indophenol, is formed when a solution of an ammonium salt is added to sodium phenoxide, followed by the addition of sodium hypochlorite [24]. To eliminate interference caused by the precipitation of calcium and magnesium hydroxides in this method, a solution of potassium sodium tartrate and sodium citrate is added to the sample stream.

4. DATA SHEETS AND TABLES

4.1 General

The analytical data (Section 3) have been reproduced in Section 5 on microfiche.

In the first set of data, the physical conditions prevailing at each station are identified and the following variables of interest recorded :

wire length, accepted depth, sea water temperature, salinity, chlorinity, dissolved oxygen, pH and total alkalinity.

In the second set of data, the concentrations of the following metal ions are tabulated :

magnesium, boron, copper, lead, cadmium and zinc

as well as the following nutrients :

phosphate, nitrate, nitrite, ammonia and silicate.

4.2 Note

Where zero appears in this compilation, viz. '0', it means that either the analysis was not carried out or that it was not reproducible.

Where a query appears, '?', the analysis has been reproducible but the value appears anomalous.

4.3 Headings

An explanation of the headings for the data sheets is given below :

<i>Station</i>	Gives the station identification; e.g. OP7803A signifies the first station in MRL cruise of March 1978.
<i>Date</i>	Given as day/month/year.
<i>Time (Table 3)</i>	Given in time zone and is the time at the beginning of the first cast.
<i>Latitude/Longitude</i>	Given in degrees and minutes.
<i>Sonic Depth</i>	Given in metres, measured at standard sound velocity of 800 fm per second.
<i>Wire Angle (Messenger release)</i>	Wire angle at surface, expressed in degrees, at time of messenger release.
<i>Wire Angle (Recovery start)</i>	Wire angle at surface, expressed in degrees, at time of recovery of bottles.
<i>Wet-Bulb Deg - C</i>	Air temperature recorded from wet bulb thermometers in °C.
<i>Dry Bulb Deg - C</i>	Air temperature recorded from dry bulb thermometers in °C.

<i>Sea Temp</i> <i>Deg - C</i>	Sea surface water temperature recorded in °C.
<i>Swell Direction,</i> <i>Amplitude (metre)</i>	Sea swell direction and amount coded using Tables 6 and 8, in US Hydrographic Manual No. 607 (Ref. 8).
<i>Wind Speed (knots)</i> <i>Direction</i>	Wind direction and speed are coded using Tables 8 and 9 in US Hydrographic Manual No. 607 (Ref. 8), Beaufort number recorded.
<i>Pressure</i>	Atmospheric pressure, millibars.
<i>Cloud</i>	Cloud amount is coded using Table 3 in US Hydrographic Manual No. 607 (Ref. 8).
<i>Secchi</i>	Water transparency measurement for black and white discs, in metres.
<i>Water Colour</i>	Water colour measured using Forel Ule scale.
<i>Marsden Square</i>	Location identifier.
<i>Length</i>	Amount of hydrographic wire deployed at sampling depth, in metres.
<i>Depth</i>	Actual sampling depth, in metres.
<i>Temp</i>	Sea temperatures recorded in °C.
<i>Salinity</i>	Given in parts per thousand.
<i>Chlorinity</i>	Given in parts per thousand.
<i>Oxygen</i>	Given in mg/l (ppm).
<i>Total Alk</i>	Total alkalinity given in milli equivalents per litre.
<i>Various Elements</i>	Parts per million, by weight, etc.
<i>Nutrients</i>	Micrograms of atom per litre.

5. ANALYTICAL DATA, INDIAN OCEAN CRUISE (OP7803)

On the enclosed microfiche, the analytical data obtained from the above cruise have been summarised. As mentioned in the Introduction, no attempt has been made to analyse these data in detail in this report; however, these data can be compared with those reported in the literature [25] relating to the world's oceans, overall (Table 4). There are some apparent differences and these will be commented on later.

In Tables 5 and 6, data has been taken from the microfiche card to illustrate the reproducibility of data obtained from different casts on the same station (Table 5) and to show how the analytical data relating to heavy metal ion concentrations can vary within a water column (Table 6).

Inspection of Table 5 indicates that the precision with which temperature, salinity, dissolved oxygen concentration, pH and alkalinity, magnesium concentration and borate concentration can be measured is very high and that significant changes in these parameters do have some analytical significance.

On the other hand, the significance of variations in trace metal ion concentrations at the parts per billion level may be questioned. Variations by a factor of 3 or more do occur and this limit on the precision achievable then reflects itself on the individual accuracy of any set of measurements. Experimentally, all that may be said is that, using anodic stripping voltammetry, which is presently the most sensitive and most satisfactory technique available for measuring trace metal levels at these concentration levels [19b], variations in concentrations do occur within the water column (Table 6), but the experimental uncertainty with regard to any one value possibly clouds the significance of the variations at these concentration levels.

6. APPLICATION OF THESE RESULTS

6.1 Deep Ocean Sound Channel Characteristics

From the literature, it appears that a major part of any undersea surveillance capability depends on the ability to locate the position of submerged submarines by sound fixing and ranging (SOFAR) techniques [26,27], the accuracy of a "fix" being very dependent upon the use of a correct sound speed in the deep ocean sound channel [27].

The speed of sound in sea water can be calculated very accurately from a knowledge of the depth, salinity and temperature of the sea [1,28], parameters which were measured on this cruise. From this, one can then deduce not only the depth of the SOFAR channel but also its variation with location (Tables 7 and 8).

An oversimplified but enlightening sound speed equation, applicable for $T \approx 0-6^{\circ}\text{C}$, $S \approx 35$ ppt and $D < 1000$ m, enables one to appreciate how the speed of sound depends on oceanographic parameters, viz.

$$v = 1449.14 + 4.57 T + 1.4 (S-35) + 0.016 D$$

where v is the speed of sound (m sec^{-1}) at a depth D (metre) in sea water at a temperature T ($^{\circ}\text{C}$) and salinity S (parts per thousand) [29].

This equation indicates that, near the SOFAR axis, which occurs at depths of about 950 m, the sound velocity is influenced mainly by temperature changes, to the extent of $\text{ca. } 4.6 \text{ m sec}^{-1} (^{\circ}\text{C})^{-1}$.

6.2 Low Frequency and Intermediate Frequency Sound Absorption

Active and passive sonars operate in different parts of the acoustical spectrum, low-frequency absorption of the sonar energy being due primarily to the presence of borate and complexed carbonate species in solution [3,30,31], and intermediate sound absorption being due to magnesium sulphate ion pairs in sea water [4].

The magnitude of these sound absorption processes and the relaxational frequency about which they are centred depend on the salinity, temperature, depth, pH and alkalinity, and can be calculated from them, using appropriate equations [3,4,30]. These results will be the subject of a separate report from these laboratories, (MRL Report 788).

6.3 Magnesium, Boron and Alkalinity

Magnesium is considered to be one of the major cations present in sea water [25] and, from comprehensive studies by Culkin and Cox and others (quoted in Ref. 32), it has been suggested that there is a relatively constant generalized ratio of magnesium : chlorinity in sea water of the order of 0.066g.

When this ratio is calculated from the experimental data presented in Table 5, the values obtained (Table 9) are much lower than the generalized figure, suggesting that there are apparently rather large anomalies in these generalized values.

In addition, it can also be noted that the concentration of magnesium at Station B over the whole water column is considerably lower than that at the other stations. The reason for this is not apparent but it should be borne in mind, especially if one is going to compare observed and calculated variations in intermediate frequency sound attenuation parameters in this area of the Indian Ocean [4].

The concentration of boron as borate in sea water of 35 ppt salinity has been cited to have a value of ca. $4.5 \pm 0.2 \text{ mg kg}^{-1}$ or ppm [32], values which cover the range of the MRL Cruise data presented in Table 5, $4.60 \pm 0.07 \text{ ppm}$.

In Table 10, the relative concentrations of various ions which contribute to the total alkalinity of sea water, 35 ppt salinity and pH 8.0, is given. These data come from that provided by Stumm and Morgan [33]. It can be seen that the main contribution to the alkalinity of sea water is that from bicarbonate, estimated to be ca. $2.5 \times 10^{-3} \text{ mequiv. l}^{-1}$, that from borate being ca. $0.04 \times 10^{-3} \text{ mequiv. l}^{-1}$.

These values are comparable with those of Table 5.

6.4 Environmental Chemistry : Heavy Metal Ions in the South-East Indian Ocean

In Section 5, it was pointed out that there are differences between the analytical figures obtained in this cruise for the concentrations of the various heavy metal ions (for example, Table 5) and those summarizing the literature (for example, Table 4). However, the significance of these differences is debatable, not only because of the inherent difficulties in defining

the accuracy of any particular analytical procedure at these levels of concentration, but also because generalized data such as in Table 4 are not necessarily representative of individual areas. In addition, no one measurement in an area necessarily reflects the character of the total water column (Table 6).

To illustrate these problems, in Table 11 results from Table 5 and those of several other research groups investigating waters from several different oceans have been listed together and compared with those listed by Brewer in his review, "Minor Elements in Sea Water" [25].

The only major discrepancy between these results and those of Brewer arises in the case of lead, where there has been considerable dispute in the literature for a long time [34]. It would appear that the lower values, quoted by Brewer, are probably correct [35].

The important thing from our point of view is that our techniques and the data we obtain are reliable and reproducible and that they can be used at least to detect and to discriminate against major changes with an acceptable degree of precision and confidence. Results from interlaboratory studies confirm the overall accuracy of our work [36].

7. SUMMARY

In this report, the principal aim of which was to document the scientific data arising from an oceanographic cruise, some attempt has been made to indicate how these data may be used.

The systematic surveying and mapping of chemical and physicochemical quantities in an ocean is difficult, painstaking and sometimes tedious; however, it is also necessary. As far as the authors can ascertain, this has been the first comprehensive survey and presentation of a chemical investigation done in this part of the Indian Ocean, probing the deep ocean waters below ca. 1000 m and one hopes these end results may be useful and worthwhile. Of the material presented for discussion, the authors chose topics reflecting their own expertise and interests; they admit it has been rather selective and acknowledge that there are many other topics, using the data reported herein, which may appeal to other physical and chemical oceanographers [37-40].

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T A B L E 1

GENERAL TIMETABLE OF TRAVEL BETWEEN STATIONS

INDIAN OCEAN CRUISE OP7803 (HMAS DIAMANTINA)

Station	Location		Day	Date	Arrival	Departure
	Latitude °S	Longitude °E				(Perth Time)
	Fremantle		Tues	280278	-	0830
A	29°40'	111°31'	Wed	010378	0400	0715
B	26°56'	107°18'	Thur	020378	0330	0825
C	22°58'	105°0'	Fri	030378	0500	0830
D	17°59'	105°1'	Sat	040378	0630	0950
E	13°19'	104°59'	Sun	050378	0800	1215
F	09°01'	104°59'	Mon	060378	0815	1145
G	10°15'	110°0'	Tues	070378	1025	1340
H	14°40'	112°0'	Wed	080378	1200	1515
J	19°30'	112°0'	Thur	090378	1325	1545
K	24°0'	112°0'	Fri	100378	1237	1355
L	29°0'	113°31'	Sat	110378	1320	1500
-	Fremantle		Sun	120378	1130	-

Locations on station were fixed by SATNAV co-ordinates.

T A B L E 2

GENERAL INFORMATION ON ACTIVITY AT EACH STATION

INDIAN OCEAN CRUISE OP7803 (HMAS DIAMANTINA)

Station	Depth (m)	Comments
A	5280*	2 Casts, 1 x 1000 m, 1 x 4000 m, 10 bottles each cast.
B	5670*	As for A. On second cast, messenger snagged on 4th bottle. Cast repeated.
C	5200 ^φ	As for A.
D	5500 ^φ	As for A. 4000 m sample missed. Messenger snagged on twisted hydrowire.
E	6100 ^φ	As for A.
F	5666*	As for A.
G	7700 ^φ	As for A.
H	4416*	As for A.
J	2030*	One cast to 1530 m. 13 bottles. Corer tested and found defective.
K	960*	One cast to 850 m. 10 bottles. Modified corer used. Core sample obtained.
L	1120*	As for K.

* PDR depth.

^φ Nominal depth. PDR depth unavailable.

Typical currents on station : $\frac{1}{2}$ - $\frac{3}{4}$ knot.

T A B L E 3

CODE FOR TIME ZONES

Longitude		Time Zone (hrs)	Code
Exceeding	Up to but not Exceeding		
07°30'E	22°30'	-1	A
22°30'E	37°30'E	-2	B
37°30'E	52°30'E	-3	C
52°30'E	67°30'E	-4	D
67°30'E	82°30'E	-5	E
82°30'E	97°30'E	-6	F
97°30'E	112°30'E	-7	G
112°30'E	127°30'E	-8	H
127°30'E	142°30'E	-9	J
142°30'E	157°30'E	-10	K
157°30'E	172°30'E	-11	L
172°30'E	180°	-12	M
180°	172°30'W	+12	Y
172°30'W	157°30'W	+11	X
157°30'W	142°30'W	+10	W

T A B L E 4

THE ABUNDANCES OF SELECTED CHEMICAL ELEMENTS
IN THE SEA, AS LISTED BY BREWER [25]

Element	Species	Total Concentration	
		M	$\mu\text{g l}^{-1}$ (ppb)
Mg	Mg (II)	5.3×10^{-2}	12.9×10^5
B	borate	4.1×10^{-4}	4.4×10^3
C	$\text{CO}_2/\text{CO}_3^{2-}$	2.3×10^{-3}	2.8×10^4
Si	silicate	7.1×10^{-5}	2×10^{03}
P	phosphate	2×10^{-6}	60
Cl	Cl^-	5.46×10^{-1}	18.8×10^6
Cu	Cu (II)	8×10^{-9}	0.5
Zn	Zn (II)	7.6×10^{-8}	4.9
Pb	Pb (II)	2×10^{-10}	3×10^{-2}
Cd	Cd (II)	1×10^{-9}	0.1

T A B L E 5

COMPARATIVE DATA TAKEN AT A NOMINAL DEPTH OF 1000 m WITH DIFFERENT CASTS ON THE SAME STATION

Station	A1	A2	B1	B2	C1	C2	D1	D2
Length (m)	1000	1000	1000	1000	1000	1000	1000	1000
Depth (m)	941	939	927	915	963	961	946	917
Temp (C)	4.63	4.60	4.86	4.95	5.15	5.15	-	5.35
Salin (ppt)	34.48	34.53	34.44	34.46	34.59	34.57	34.65	34.65
Oxygen (ppm)	5.45	5.45	5.71	5.83	4.01	4.01	3.08	3.26
pH	7.94	7.99	7.95	7.96	-	7.90	7.85	7.86
Tot-Alk (m Eq/L)	2.32	2.32	2.34	2.33	-	2.44	2.30	2.32
Mg (ppm)	1252	1251	1170	1175	1242	1247	1262	1276
B (ppm)	4.53	4.60	4.56	4.63	4.68	4.57	4.66	4.61
Cu (ppb)	2.32	1.08	0.90	0.99	1.38	0.77	1.70	0.91
Pb (ppb)	1.36	0.95	0.44	0.64	0.69	0.93	0.64	0.73
Cd (ppb)	0.06	0.05	0.05	0.07	0.03	0.03	0.05	0.06
Zn (ppb)	2.36	3.67	1.59	-	1.50	3.77	-	-

T A B L E 6

THE VARIATION OF HEAVY METAL ION CONCENTRATIONS
WITHIN A WATER COLUMN : STATION C1 (OP7803)

Length (m)	Depth (m)	Cu (ppb)	Pb (ppb)	Zn (ppb)
50	47	0.65	0.55	6.41?
100	94	0.33	0.55	1.40
150	142	1.19	0.90	1.53
200	188	0.74	0.24	3.02
300	284	0.95	1.33	0
400	379	1.02	0.40	0.94
600	573	0.49	0.33	6.73
800	768	1.85	1.16	3.63
1000	963	1.38	0.69	1.50

Concentrations are in units of ppb, parts per billion

T A B L E 7

CHARACTERISTICS OF THE DEEP OCEAN SOUND CHANNEL ALONG THE
SO FAR AXIS AS DETERMINED FROM MRL CRUISE OP7803
IN THE SOUTH-EAST INDIAN OCEAN, MARCH 1978

Station	Station Depth (m)	Channel Characteristics				Sound Vel. (m sec ⁻¹)
		Depth (m)	Temp. (C)	Salin. (ppt)	pH	
A	5280	940	4.6	34.5	7.94	1484
B	5670	925	4.9	34.4	7.96	1485
C	5200	960	5.1	34.6	7.90	1486
D	5500	920	5.4	34.7	7.85	1487
E	6100	950	5.3	34.6	7.81	1487
F	5666	1175(?)	4.7	34.8	7.80	1489
G	7700	925	5.3	34.6	7.81	1486
H	4416	940	5.3	34.6	7.79	1487
J	2030	>905	5.9	34.6	7.85	1487
K	960			t o o s h a l l o w		
L	1120			t o o s h a l l o w		

T A B L E 8

DEEP OCEAN SOUND CHANNEL AXIS DATA FOR OCEANS OF THE WORLD

Ocean	Location	Month	Axis Depth (m)	Temp (C)	Salin (ppt)	pH	Sound Speed (m sec ⁻¹)
Indian	5°-20°N 105°-112°E	March	940	5.1	34.6	7.84	1487
G. Aden		May	300	14.3	35.7	7.83	1511
Medit.		Aug.	150	14.2	38.7	8.19	1511
Red		Nov.	190	22.1	40.5	8.20	1537
Atlantic	30°-40°N 50°-60°W	Feb.	1321	4.7	35.0	8.09	1492
Pacific	30°-40°N 150°-160°W	March	892	3.7	34.1	7.70	1479
Baffin	70°-80°N 60°-70°W	July	50	-1.5	33.7	8.02	1441

Source : Reference 3 and this work.

T A B L E 9

MAGNESIUM : CHLORINITY RATIOS CALCULATED FROM COMPARATIVE DATA
TAKEN AT A NOMINAL DEPTH OF 1000 m AT STATIONS A TO D

Station	Depth (m)	Mg (ppt)	Cl (ppt)	Mg : Cl
A1	941	1.252	19.086	0.06560
A2	939	1.251	19.114	0.06545
B1	927	1.170	19.066	0.06137
B2	915	1.175	19.227	0.06112
C1	963	1.242	19.146	0.06487
C2	961	1.247	19.134	0.06517
D1	946	1.262	19.182	0.06579
D2	917	1.276	19.181	0.06652
Average		1.234	19.142	0.0645

T A B L E 10

DISTRIBUTION OF SPECIES EFFECTING THE ALKALINITY
OF SEA WATER AT pH 8.0, SALINITY 35 ppt,
AS LISTED BY STUMM AND MORGAN [33]

<u>Species</u>	<u>Conc. (M)</u>
H_2CO_3	5.6×10^{-5}
HCO_3^-	2.5×10^{-3}
CO_3^{--}	1.6×10^{-5}
H^+	10^{-8}
OH^-	10^{-6}
B(OH)_3	4.0×10^{-4}
B(OH)_4^-	4.0×10^{-5}
Si(OH)_4	1.7×10^{-4}
SiO(OH)_3^-	5.6×10^{-6}

T A B L E 11

COMPARISON OF THE TRACE ELEMENT CONCENTRATIONS IN SEA WATER
DETERMINED BY DIFFERENT AUTHORS

Reference	Analysis	Cu	Pb	Cd	Zn
(m i c r o g r a m p e r l i t r e)					
This Work (Table 5)	ASV	0.8-2.3 av. 1.3	0.4-1.4 av. 0.8	0.03-0.06 av. 0.05	1.5-3.8 av. 2.6
MRL OP7502 (Ref. 19b)	ASV	0.03-4.5 av. 1.2	0.1-2.7 av. 1.0	0.02-0.54 av. 0.04	1.5-8.6 av. 4.4
Chester & Stone (Ref. 19b)	S	0.1-3.9	-	0.02-0.30	0.4-13
Brewer et al. (Ref. 19b)	AA	0.3-2.8	-	-	1.1-10
Florence (Ref. 35)	ASV	0.9-9.8	0.4-1.9	0.3-1.0	2.8-6.5
Brewer (Table 4)	Review	0.5	0.03	0.1	4.9

Note: ASV = anodic stripping voltammetry

S = spectrophotometry

AA = atomic absorption spectroscopy

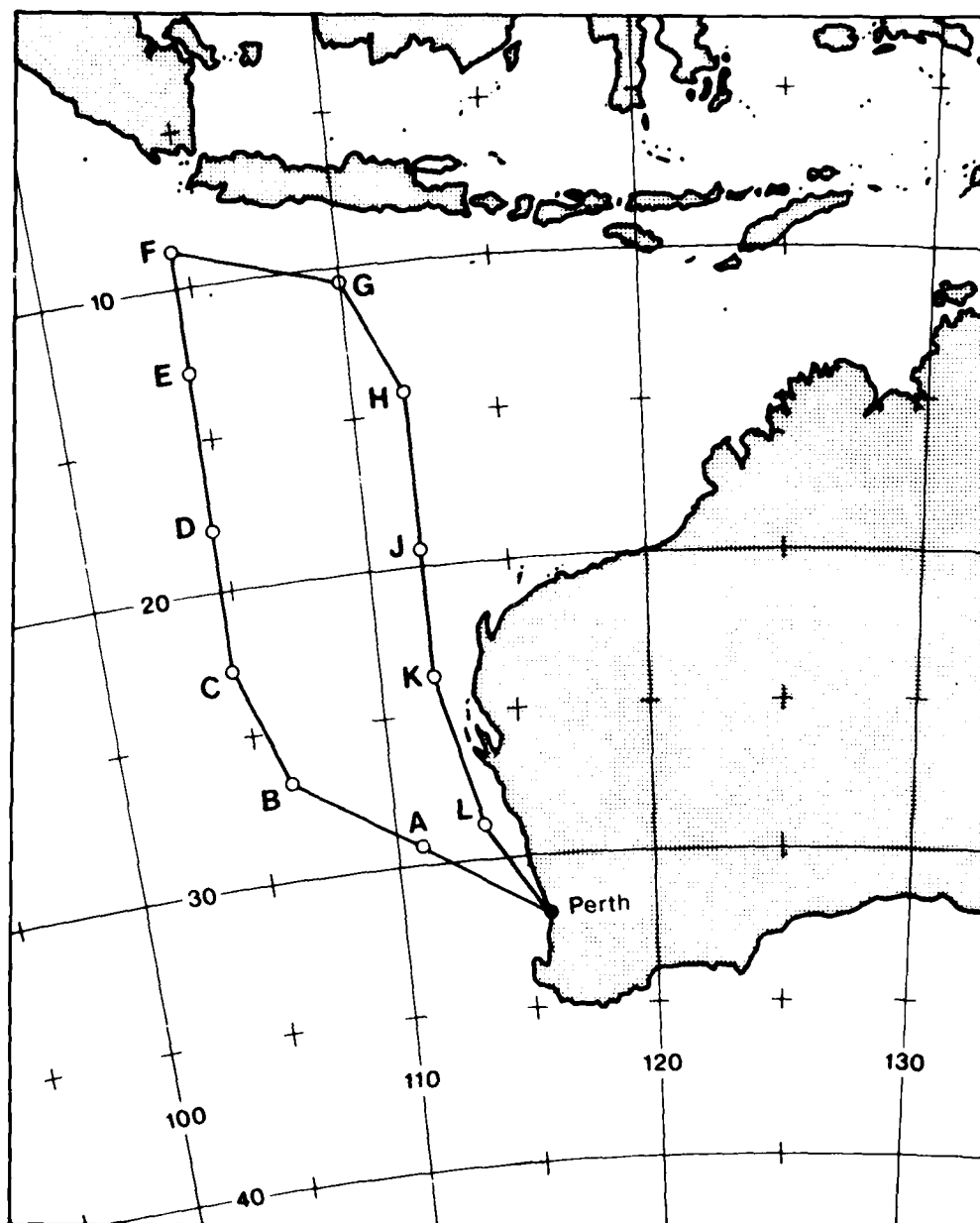


FIG. 1 - Course of MEG Oceanographic Cruise, OP7803, carried out on board HMAS Diamantina (February-March 1978).

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ANNUAL REPORT ON RESEARCH AND DEVELOPMENT 1977-1978

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11

Defence Science and Technology Group

MATERIALS DESIGN LAB (10-11)

RESEARCH AND DEVELOPMENT REPORT

Chief of the Department of Defence Science and Technology
P.O. Box 50, Canberra, Australia

The work described in this report was carried out
in the Marine Environment Group of the Physical
Chemistry Division, Materials Research Laboratories
as part of the Group's contribution to the tasks,

TR 70/120 Marine Chemistry Research

and

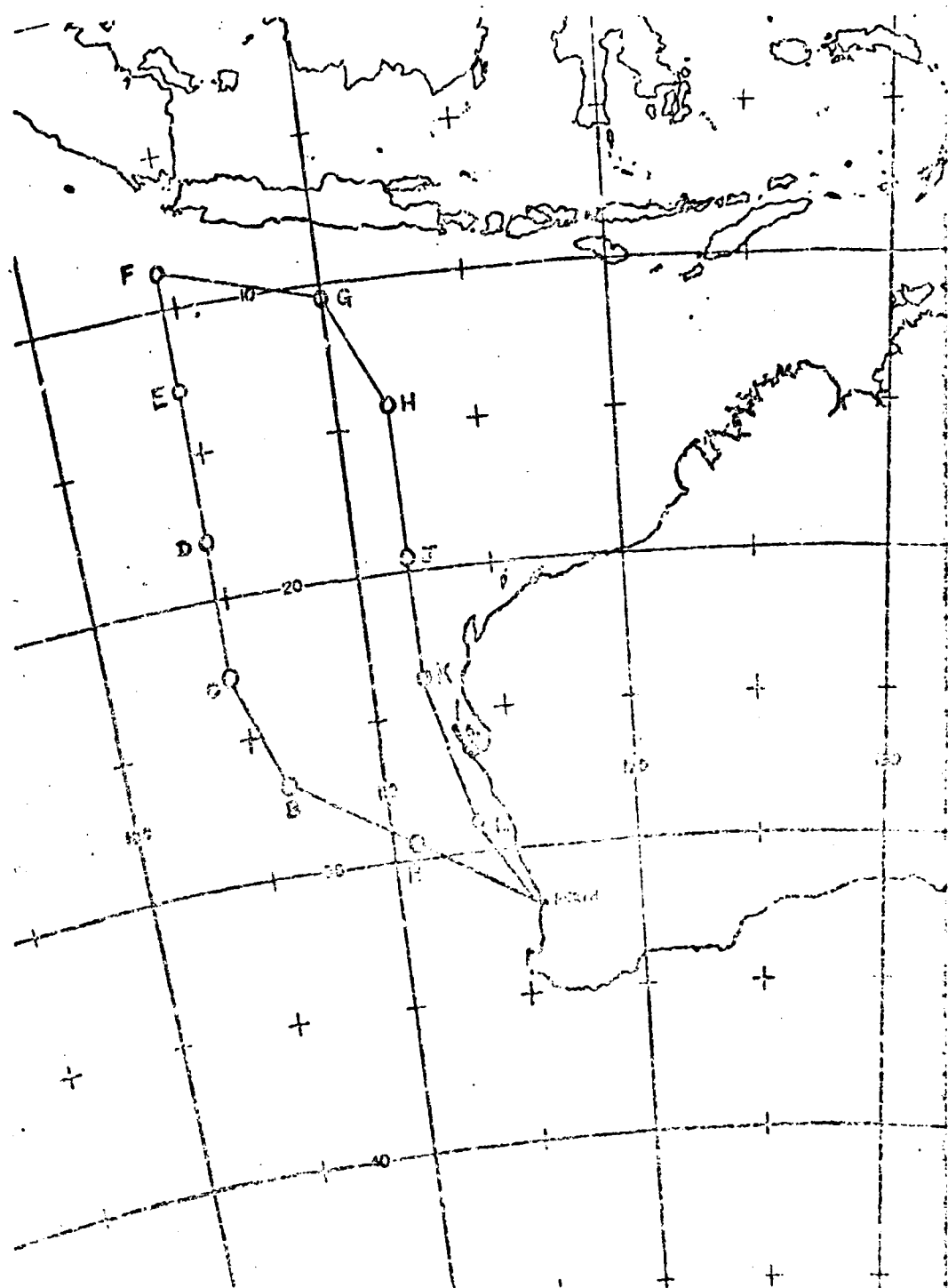
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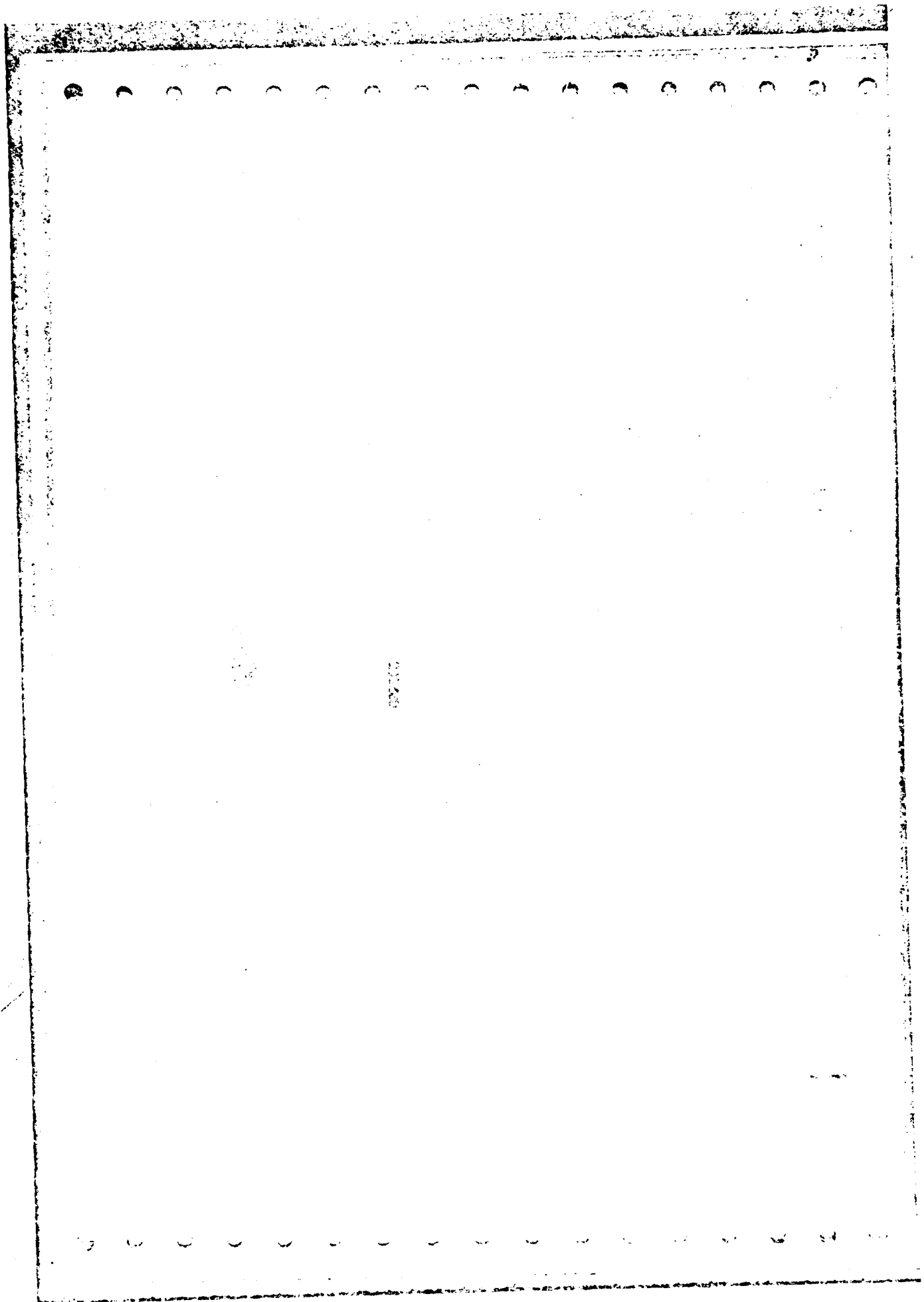
TABLE 1

GENERAL TIMETABLE OF TRAVEL BETWEEN STATIONSINDIAN OCEAN CRUISE GP7803 (HMAS DIAMANTINA)

Station	Location		Day	Date	Arrival	Departure
	Latitude °S	Longitude °E				(Perth Time)
		Fremantle	Tues	280278	-	0830
A	29°40'	111°31'	Wed	010378	0400	0715
B	26°50'	107°18'	Thur	020378	0330	0625
C	22°58'	105°0'	Fri	030378	0500	0830
D	17°59'	105°1'	Sat	040378	0630	0950
E	13°19'	104°59'	Sun	050378	0800	1215
F	09°01'	104°59'	Mon	060378	0915	1145
G	10°15'	110°0'	Tues	070378	1025	1340
H	14°40'	112°0'	Wed	080378	1200	1530
J	15°30'	112°0'	Thur	090378	1325	1545
K	24°0'	112°0'	Fri	100378	1237	1555
L	29°0'	113°31'	Sat	110378	1320	1500
		Fremantle	Sun	120378	1130	-

Locations on station were fixed by DALLAS co-ordinates





STATION	DATE	TIME	LAT-E	LONG-S	TIME-ZONE
DATA	DATA	DATA	DATA	DATA	DATA

AI	010376	0000	29.40	111.31	0
----	--------	------	-------	--------	---

WIRE-ANGLE (DEG)		WET-BUILD		SEA-TEMP		SONIC-DEPTH	
WESSEMBER-RELEASE	RECOVERY-START	WET-BUILD	WET-BUILD	SEA-TEMP	SEA-TEMP	SONIC-DEPTH	SONIC-DEPTH
(DEG)	(DEG)	DEG-C	DEG-F	DEG-C	DEG-F	(M)	(M)

0400	0715	0	0	22.8	73.0	5200	5200
------	------	---	---	------	------	------	------

SHELL		WAVE-HEIGHT		WIND		PRESSURE	
DIRECTION	AMPLITUDE	WAVE-HEIGHT	WAVE-HEIGHT	DIRECTION	WIND	PRESSURE	PRESSURE
(DEG)	(M)	(M)	(M)	(DEG)	(KTS)	(MM HG)	(MM HG)

0	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---

WELCH		CLOUD		WATER-COLOUR		BAROMETRIC-CHANGE	
WHITE	BLACK	CLOUD	CLOUD	WATER-COLOUR	WATER-COLOUR	BAROMETRIC-CHANGE	BAROMETRIC-CHANGE
(%)	(%)	(%)	(%)	(%)	(%)	(MM HG)	(MM HG)

0	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---

WATER COLOUR DATA AND 4- FORM SCALE 01-011

WIND SCALE 01-011

DEPTH	TEMP	TEMP	TEMP	TEMP	TEMP	TEMP	TEMP
(M)	(C)	(C)	(C)	(C)	(C)	(C)	(C)
DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA
20	18	22.764	35.782	19.037	6.99	8.28	2.27
35	18	22.440	35.77	19.8	7.04	8.29	2.29
100	18	19.919	35.764	19.07	7.25	8.3	2.27
150	17	17.703	35.75	19.77	7.45	8.31	2.27
200	16	15.17	35.7	19.720	7.41	8.29	2.25
250	15	13.377	35.700	19.73	7.63	8.22	2.27
300	14	11.320	35.671	19.72	6.65	6.25	1.93
400	10	9.350	35.620	19.228	7.53	8.12	2.0
500	7	7.07	35.495	19.191	6.71	8.07	2.2
1000	7	4.509	24.451	19.004	5.43	7.14	2.22

LENGTH (IN) *****	MAGNESIUM PPM *****	BORON PPM *****	COPPER PPM *****	LEAD PPM *****	CADMIUM PPM *****	ZINC PPM *****	IRON PPM *****
20	1295	4.77	3.98	2.15	0.83	1.5	0
50	1302	4.78	1.26	0.33	0.82	1.1	0
100	1297	4.84	2.46	1.18	0.86	1.05	0
150	1304	4.81	1.27	1.66	0.86	1.02	0
200	1292	4.7	0.78	0.81	0.81	0	0
300	1284	4.68	0.69	0.75	0.81	1.91	0
400	1266	4.71	0.76	0.69	0.83	1.75	0
600	1260	4.64	3.32	2.55	0.83	1.73	0
800	1250	4.59	1.96	0.95	0.83	2.22	0
1000	1232	4.53	2.32	1.35	0.86	2.56	0

LENGTH (IN) *****	FOUR-P *****	TOT-P *****	NO2-N *****	NO3+NO2 *****	NO3-N *****	NO2-N *****	PHOS-P *****
20	0.3	0	0	0	0	0.34	10.32
50	1.2	0	0	0	0	0	0
100	0.18	0	0	0	0	0	0
150	0.57	0	0	2.47	2.47	0.71	29.78
200	0.81	0	0	0	0	0	3.01
300	0.34	0	0	0	0	1.12	0
400	0.29	0	0	0	0	0	2.00
600	0.96	0	0	0	0	0.82	6.65
800	1.76	0	0.25	0.31	3.05	0.97	0
1000	2.72	0	0	0	0	1.79	41.85

STATION DATA	DATE DATA	TIME Hrs DATA	LAT-E (DEG) DATA	LONG-S (DEG) DATA	TIME-ZONE DATA
7803A2	010378	0400	29.45	111.31	8

WIRE-ANGLE (DEG) DATA		MESSENGER-RELEASE (DEG) DATA	RECOVERY-START (DEG) DATA	WET-BULB Deg-C DATA	DRY-BULB Deg-C DATA	SEA-TEMP Deg-C DATA	SONIC-DEPTH (ft) DATA
0445	0700	23.0	23.5	22.8	5250		

SUELL DATA		WIND DATA		PRESSURE DATA	
DIRECTION (DEG) DATA	AMPLITUDE (ft) DATA	WAVE-HEIGHT (ft) DATA	SPEED Kts DATA	DIRECTION (DEG) DATA	PRESSURE IN-Hg DATA
140	02	0.4	10	115	1014.3

OCCUR DATA		WATER-COLOUR DATA		RANSEN-SOURCE DATA	
WHITE (ft) DATA	BLACK (ft) DATA	CLOUD (10/100) DATA	WATER-COLOUR DATA	RANSEN-SOURCE DATA	DATA
0	0	04	0	394	

WATER COLOUR UNITS ARE 1/100 SCALE FT-FT

WIND SCALE 01-011

DEPTH (ft) DATA	TEMP (C) DATA	SALIN PPT DATA	TEMP PPT DATA	WIND PPH DATA	WIND PPH DATA	WIND PPH DATA	WIND PPH DATA
1000	9.59	34.53	19.114	5.45	7.97	2.32	
1200	1127	34.557	19.13	4.45	7.95	2.30	
1500	1412	34.653	19.182	4.49	7.98	2.41	
1700	1403	34.757	19.226	4.05	7.95	2.41	
2000	1096	34.704	19.211	3.11	7.95	2.40	
2300	2374	34.773	19.224	5.3	7.94	2.43	
2500	2246	34.77	19.200	5.93	7.97	2.43	
4000	10.3	34.722	19.225	6.2	7.95	2.43	

LENGTH (IN) DEPTH	BARFESTION PPH DEPTH	BORON PPH DEPTH	COPPER PPH DEPTH	LEAD PPH DEPTH	CADMIUM PPH DEPTH	ZINC PPH DEPTH	IRON PPH DEPTH
1000	1231	4.6	1.08	0.95	0.85	1.67	0
1200	1238	4.67	2.48	1.20	0.05	1.31	0
1500	1272	4.6	1.57	1	0.11	1.66	0
1700	1250	4.6	1.42	0.66	0.07	2.48	0
2000	1253	4.56	1.69	2.28	0.64	0.77	0
2500	1255	4.59	1.25	0.45	0.04	1.29	0
3000	1240	4.61	2.7	2.82	0.04	1.49	0
3500	1247	4.59	6.98	0.53	0.07	0.44	0
4000	1255	4.61	0.66	0.66	0.83	0.8	0

LENGTH (IN) DEPTH	SDS-P PPH DEPTH	THY-P PPH DEPTH	SPC-W PPH DEPTH	NOTAFES PPH DEPTH	MS-41 PPH DEPTH	PRC-8 PPH DEPTH	BIOM-11 PPH DEPTH
1000	0	0	1.17	18.8	17.62	0	0
1200	2.22	0	0	17.79	17.79	1.38	38.64
1500	2.67	0	0	0	0	0	39.83
1700	2.7	0	1.3	18.83	17.53	0	46.62
2000	2.85	0	1.05	21.45	19.63	0	60.44
2500	2.58	0	0	0	0	0.88	45.07
3000	0	0	1.12	14.38	13.92	0	47.57
3500	1.55	0	1.52	11.58	15.91	1.41	50.4
4000	1.41	0	1.51	22.37	21.05	0	39.51

STATION	DATE	TIME	LAT-C	LONG-B	TIME-ZONE
DATA	DATA	DATA	(DEG)	(DEG)	DATA
81	020378	0330	26.56	107.18	N

WIRE-ANGLE (DEG)		NET-BUILD	DRT-BUILD	SEA-TEMP	SONIC-DEPTH
RESENDER-RELEASE	RECOVERY-START	Reg-C	Reg-C	Reg C	(M)
DATA	DATA	DATA	DATA	DATA	DATA
0405	0425	22.7	22.0	12.7	5670

SUELL		WIND		PRESSURE	
DIRECTION	AMPLITUDE	WAVE-HEIGHT	SPEED	DIRECTION	N-PAR
(DEG)	(M)	(M)	Kts	(DEG)	DATA
DATA	DATA	DATA	DATA	DATA	DATA
135	01	0	19	145	1016.5

SUELL		WIND		PRESSURE	
WHITE	BLACK	CLOUD	WATER-COLOR	WATER-COLOR	WATER-COLOR
(M)	(M)	(10/100)	DATA	DATA	DATA
DATA	DATA	DATA	DATA	DATA	DATA
0	0	10	0	0	317

*WATER COLOUR UNITS ARE 1- FOGEL SCALE P1-F11

ULE SCALE U1-U11

LENGTH	DEPTH	TEMP	SALIN	CHLOR	OXYGEN	PH	WATER
(M)	(M)	(C)	PPT	PPT	PER	DATA	DATA
DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA
20	19	22.679	35.706	19.765	7.09	8.21	2.34
30	46	22.46	33.69	19.756	7.1	8.26	2.32
100	93	19.692	35.795	19.814	7.49	8.27	2.33
150	139	18.009	35.8	19.812	7.12	8.25	2.32
200	185	16.860	35.730	19.782	7.4	8.24	2.33
260	278	13.911	35.384	19.386	7.31	8.21	2.35
400	349	11.671	25.652	19.435	7.7	8.17	2.37
600	550	9.359	24.763	19.254	7.76	8.03	2.32
810	737	7.613	24.602	17.124	7.01	8.02	2.33
1000	927	4.861	34.414	17.864	5.71	7.15	2.34

LENGTH (M)	MAGNESIUM PPM	POTASH PPM	COPPER PPM	LEAD PPM	CADMIUM PPM	ZINC PPM	IRON PPM
20	1203	4.7	2.59	1.72	0.05	1.34	0
50	1202	4.68	1.8	2.84	0.03	0.65	0
100	1194	4.72	1.22	1.43	0.05	1.93	0
150	1200	4.72	2.47	2.12	4.07	1.03	0
200	1183	4.81	2.05	0.59	0.07	0.25	0
300	1194	4.65	1.25	0.71	0.03	0.86	0
400	1190	4.59	1.54	0.87	0.05	0.8	0
600	1179	4.6	0.73	0.45	0.03	1.93	0
800	1186	4.57	0.62	0.6	0.11	0.55	0
1000	1170	4.56	0.9	0.64	0.05	1.39	0

LENGTH (M)	COBALT PPM	CHROMIUM PPM	CHLORINE PPM	MOSELEY PPM	PHOSPHORUS PPM	SILICON PPM
50	0	0	0	0	0	0
100	0	0	0	0	0	0
150	0.21	0	0	0	0	4.42
200	1.44	0	0	0	0	21.07
300	0	0	0	0	0.70	0
400	0	0	0	0	0	0
600	1.39	0	0	0	0	16.79
800	1.64	0	0	0	0.01	60.67
1000	2.05	0	0	0	0.12	21.04

STATION	DATE	TIME	LAT-E	LONG-S	TIME-ZONE
DATA	DATA	DATA	DATA	DATA	DATA
73	020378	0500	26.36	107.10	8

KINE-ANGLE (DEG)					
DATA	DATA	DATA	DATA	DATA	DATA
MESSIAH-RELEASE (DEG)	RECOVERY-START (DEG)	KEY-PULD Deg-C	DRY-BULD Deg-C	SEA-TEMP Deg-C	SONIC-DEPTH (M)
DATA	DATA	DATA	DATA	DATA	DATA
0420	0750	22.6	22.7	22.7	5670

SHELL		WIND			
DATA	DATA	DATA	DATA	DATA	DATA
DIRECTION (DEG)	AMPLITUDE (M)	WAVE-HEIGHT (M)	SPEED Kts	DIRECTION (DEG)	PRESSURE H-Pa
DATA	DATA	DATA	DATA	DATA	DATA
155	01	0	17	145	1016.5

SECCHI				
DATA	DATA	DATA	DATA	DATA
WHITE (M)	BLACK (M)	CLOUD (10/100)	WATER-COLOUR	MARSEN-SOURE
DATA	DATA	DATA	DATA	DATA
0	0	10	0	297

*WATER COLOUR UNITS ARE 1- FINE SCALE 01-111

W.P. SCALE 01-111

DATE	DEPTH	TEMP	SALIN	CHLOR	OXIGEN	PH	SEA-SUR
DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA
1978	915	4.945	34.442	19.876	5.83	7.96	2.21
1979	1116	4.9	34.529	19.113	4.73	7.92	2.30
1980	1403	2.520	34.363	19.154	4.41	7.88	2.29
1981	1070	2.24	34.650	19.184	4.70	7.89	2.41
1982	1092	2.694	34.775	19.249	5.12	7.92	2.42
1983	2234	2.959	34.705	19.278	5.42	7.93	2.44
1984	2002	1.970	34.744	19.282	5.8	7.93	2.43
1985	3371	1.665	34.774	19.210	6.12	7.94	2.25
1986	2975	1.440	34.770	19.227	6.34	7.97	2.30

PAGE

LENGTH (ft) FOOT	POTASSIUM PPH PPH	SODIUM PPH PPH	COPPER PPH PPH	LEAD PPH PPH	CADMIUM PPH PPH	ZINC PPH PPH	IRON PPH PPH
1000	1172	4.63	0.97	1.64	0.01	0	0
1200	1162	4.67	1.25	1.79	1.03	0.79	0
1500	1165	4.63	1.21	1.38	0.04	1.05	0
1700	1163	4.64	1.01	1	0.01	1.38	0
2000	1134	4.62	1.04	1.34	0.02	0.04	0
2500	1151	4.66	0.66	0.73	0.04	1.72	0
3000	1194	4.65	0.91	1.38	0.09	0.30	0
3500	1189	4.64	1.23	0.69	0.03	2.34	0
4000	1200	4.65	1.9	2.67	0.05	2.03	0

PAGE

LENGTH (ft) FOOT	1000 FOOT	1500 FOOT	2000 FOOT	2500 FOOT	3000 FOOT	3500 FOOT	4000 FOOT
1000	0	0	6.14	15.3	0.16	0	0
1200	0	0	0	0	0	0	0
1500	0	0	2.15	12.23	0.1	0	0
1700	2.31	0	0	0	0	0.76	20.02
2000	0	0	0	0	0	1.5	0
2500	2.64	0	0	0	0	0	45.02
3000	2.24	0	0.91	15.75	0.04	0	25.01
3500	1.74	0	0	0	0	1.4	0
4000	2.42	0	2.35	28.64	20.29	0	47.14

STATION	DATE	TIME	LAT-E	LONG-S	TIME-ZONE
DATA	DATA	DATA	DATA	DATA	DATA

01	030370	0500	22.50	105.00	8
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WIDE-ANGLE (DEG)

MESSANGER-RELEASE	RECOVERY-START	WET-BULB	DRY-BULB	SEA-TEMP	SONIC-DEPTH
(DEG)	(DEG)	DEG-C	DEG-C	DEG-C	(M)

0540	0555	0	0	21.3	5200
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WIND

DIRECTION	AMPLITUDE	WAVE-HEIGHT	SPEED	DIRECTION	PRESSURE
(DEG)	(M)	(M)	KT	(DEG)	IN-HG

0	0	0	15	105	0
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DEPTH

WHITE	BLACK	COLOR	WATER-COLOR	BAROMETRIC
(M)	(M)	(10/100)	DATA	DATA

36.0	21.0	10	501	197
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WATER COLOR UNITS ARE ON FOREL SCALE 11-F11

WIND SCALE 01-011

DEPTH	TEMP	SALIN	CHLOR	STYXON	PH	TEMP
(M)	(C)	PPT	PPT	PPT		(C)
25	22	35.678	35.689	19.755	8.87	2.32
50	22	35.672	35.686	19.752	8.93	2.35
100	22	35.656	35.651	19.734	7.28	2.32
150	22	35.653	35.641	19.781	6.65	2.32
200	22	35.656	35.62	19.817	6.01	2.32
250	22	35.654	35.597	19.754	7.12	2.32
300	22	35.637	35.527	19.441	7.34	2.34
400	22	35.447	35.636	19.172	7.37	2.34
500	22	0	34.428	19.01	5.01	0
1000	22	3.145	34.525	19.146	4.01	0

LENGTH (M) DEPTH	MAGNESIUM PPM DEPTH	BORON PPM DEPTH	COPPER PPB DEPTH	LEAD PPB DEPTH	CADMIUM PPB DEPTH	ZINC PPB DEPTH	IRON PPB DEPTH
20	1232	4.81	0.32	0.28	0.03	0	0
30	1230	4.83	0.63	6.55	6.00	6.41	0
100	1274	4.75	0.33	0.55	0.03	1.4	0
150	1287	4.61	1.19	0.9	0.93	1.53	0
200	1277	4.85	0.74	0.24	0.03	3.02	0
300	1203	4.9	0.95	1.33	0.03	0	0
400	1242	4.72	1.62	0.4	0.03	0.94	0
600	1210	4.67	0.49	0.33	0.33	6.73	0
800	1245	4.64	1.05	1.14	0.93	3.67	0
1000	1242	4.68	1.39	0.09	0.63	1.3	0

LENGTH (M) DEPTH	COBALT PPB DEPTH	CHROMIUM PPB DEPTH	NIICKEL PPB DEPTH	THALLIUM PPB DEPTH	SILICON PPB DEPTH	PHOSPHORUS PPB DEPTH	ANTIMONY PPB DEPTH
20	0.80	0	0	0	0	0	17.55
30	4.38	0	0	0	0	0	17.17
100	0	0	0	0	0	0	77.56
150	0	0	0	0	0	1.73	14.14
200	0	0	0	0	0	0	0
300	0.07	0	0	0	0	0	6.88
400	0	0	0	0	0	0	0
600	2.07	0	0	0	0	0	41.24
800	1.52	0	0	0	0	0	41.22
1000	0	0	0	0	0	0.3	0

STATION DATA	DATE DATA	TIME DATA	LATITUDE (DEG) DATA	LONGITUDE (DEG) DATA	TIME-ZONE DATA
C2	030370	0500	22.20	105.10	8

WIRE-ANGLE (DEG) DATA		ESSENGER-RELEASE RECOVERY-START (DEG) DATA	DET-CULB Deg-C DATA	DRT-WULB Deg-C DATA	SEA-TEMP Deg-C DATA	SONIC-DEPTH (m) DATA
0610	0700	0	6	21.2	5210	

SWELL DATA		WIND DATA		PRESSURE DATA	
DIRECTION (DEG) DATA	AMPLITUDE (M) DATA	WAVE-HEIGHT (M) DATA	SPEED KTS DATA	DIRECTION (DEG) DATA	PRESSURE H-PAS DATA
0	0	0	15	160	0

SWEAT DATA		WATER-COLDER DATA		WATER-TEMPERATURE DATA	
WET (M) DATA	WET (M) DATA	WET (M) DATA	WET (M) DATA	WET (M) DATA	WET (M) DATA
35.0	21.0	10	601	397	

WATER TEMP. LIMITS ARE IN FRACTIONAL INCHES

WATER TEMP. LIMITS

WATER (M) DATA	WATER (M) DATA	WATER (M) DATA	WATER (M) DATA	WATER (M) DATA	WATER (M) DATA	WATER (M) DATA	WATER (M) DATA
1000	961	5.143	21.056	17.134	4.01	7.9	2.41
1200	1158	4.51	24.692	19.153	2.82	8.06	2.44
1500	1455	3.645	24.041	19.125	4.07	7.65	2.35
1700	1649	3.196	24.427	19.2	4.75	7.87	2.74
2000	1935	2.714	24.78	19.174	4.5	7.9	2.35
2300	2231	2.740	24.732	19.925	4.04	7.49	2.30
2500	2527	1.80	24.770	19.225	5.03	7.07	2.39
2700	2813	0.8	24.721	19.124	5.75	0	0
3000	3003	1.435	24.777	19.225	5.07	7.51	2.412

LENGTH (IN) DEPTH	MAGNESIUM PPM DEPTH	BARON PIR DEPTH	COPPER PPM DEPTH	LEAD PPM DEPTH	CADMIUM PPM DEPTH	ZINC PPM DEPTH	IRON PPM DEPTH
1000	1247	4.37	0.77	0.93	0.03	1.77	0
1200	1247	4.42	0.58	0.47	0.03	1.12	0
1500	1255	4.43	0.45	0.7	0.03	0	0
1700	1254	4.59	1.28	1.64	0.88	4.42	0
2000	1266	4.61	0.69	0.33	0.07	1.63	0
2500	1221	4.6	0.42	0.88	0.66	1.71	0
3000	1244	4.61	0.2	0.55	0.03	1.17	0
3500	1247	4.55	0.84	0.56	0.04	1.51	0
4000	1243	4.59	0.64	0.77	0.03	2.64	0

LENGTH (IN) DEPTH	COBALT PPM DEPTH	THALLIUM PPM DEPTH	ANTIMONY PPM DEPTH	POSSIBLY LEAD PPM DEPTH	MOB-P PPM DEPTH	MOB-P PPM DEPTH	LEAD-P PPM DEPTH
1000	0	0	0	0	0	0	0
1200	0	0	0	0	0	2.6	0
1500	2.49	0	1.47	21.4	19.51	1.1	33.19
1700	2.58	0	1.57	29.00	18.19	1.14	31.15
2000	2.12	0	0	0	0	0	32.1
2500	1.87	0	0	0	0	0	35.44
3000	2.4	0	1.57	12.03	10.77	0	26.42
3500	2.13	0	1.13	12.03	11.4	0	26.20
4000	2.14	0	0	0	0	0	29.83

STATION ####	DATE ####	TIME HH:MM ####	LAT-L (DEG) ####	LONG-S (DEG) ####	TIME-ZONE ####
31	040378	0630	17.98	105.01	H

WIRE-ANGLE (DEG) ####					
MESSAGE-RELEASE (DEG) #####	RECOVERY-START (DEG) #####	ULT-RELB Deg-C #####	DRY-TOLE Deg-C #####	SEA-TEMP Deg-C #####	SONIC-DEPTH (ft) #####
0710	0720	24.3	24.5	27.6	1678

SUELL ####		WIND ####			
DIRECTION (DEG) #####	AMPLITUDE (ft) #####	WAVE-HEIGHT (ft) #####	SPEED Kts ####	DIRECTION (DEG) #####	PRESSURE at 1000 #####
100	1.3	0	15	180	1019.5

SECOND ####			WATER-COLOUR ####		WATER-CLARITY ####	
WHITE (ft) ####	BLACK (ft) ####	THICK (10/100) ####				
0	0	07	0		3.1	

WATER-CLARITY (M) AND 1-1000 (M) (1-100)

WIND-TEMP (DEG)

TIME HH:MM ####	DEPTH (ft) ####	TEMP (DEG) ####	SALIN PPY ####	WIND (KTS) ####	WIND DIR ####	SEA DIR ####	SEA HGT ####
21	17	22.253	34.001	19.708	6.47	8.22	2.20
70	17	24.204	34.502	19.301	6.67	8.24	2.20
160	15	22.303	34.63	19.20	5.21	0	0
150	143	20.574	35.125	17.471	5.3	8.21	2.21
250	191	19.274	35.548	19.477	5.75	8.24	2.21
340	183	19.215	35.546	19.477	6.63	8.2	2.22
440	173	19.107	35.132	19.447	7.15	8.10	2.22
540	155	18.208	34.617	17.142	6.8	8.09	2.21
640	147	17.957	34.620	19.167	6.34	7.85	2.20
740	140	17.387	34.634	19.102	5.07	7.84	2.15

LENGTH (M) DEPTH	MAGNESIUM PPM DEPTH	BORON PPM DEPTH	COPPER PPM DEPTH	LEAD PPB DEPTH	CADMIUM PPB DEPTH	ZINC PPB DEPTH	IRON PPB DEPTH
20	1258	4.63	2.65	0.55	0.03	0	0
50	1244	4.6	0.16	0.27	0.01	2.14	0
100	1250	4.57	1.24	1.1	0.05	0	0
150	1269	4.61	0.23	0.83	0.03	0.67	0
200	1268	4.62	0	0	0	0	0
300	1290	4.78	2.21	0	0.06	1.73	0
400	1284	4.65	0.11	0.14	0.05	0	0
600	1259	4.67	0.03	0.03	0.03	0	0
800	1259	4.67	1.94	0.23	0.03	0	0
1000	1262	4.64	1.7	0.24	0.05	0	0

LENGTH (M) DEPTH	100-PPM DEPTH	100-PPM DEPTH	100-PPM DEPTH	100-PPM DEPTH	100-PPM DEPTH	100-PPM DEPTH	100-PPM DEPTH
20	0.73	0	1.3	5.28	4.46	2.10	0
50	0.6	0	0.3	5.40	4.94	0.70	4.8
100	0.10	0	0	0	0	4.20	0
150	0.33	0	0	0	0	0.61	4.0
200	0	0	0	0	0	0	0
300	1.02	0	0	0	0	0	0
400	1.35	0	0	0	0	0	12.07
600	1.21	0	0	0	0	0	23.25
800	2.41	0	4.07	12.12	0.5	0	41.7
1000	2.4	0	0	0	0	0	37.36

STATION	DATE	TIME Hrs Mins	LAT-E (HRS)	LONG-L (DEC)	TIME ZONE
B2	040378	0639	17.58	105.11	E

WIRE-ANGLE (IEG)					
MESSAGE-RECOVERY-START (DEC)	MESSAGE-RECOVERY-END (DEC)	WIRE-ANGLE (IEG)	WIRE-ANGLE (IEG)	WIRE-ANGLE (IEG)	WIRE-ANGLE (IEG)
0640	0910	24.5	24.5	27.4	3678

SHELL		WIND			
DIRECTION (IEG)	AMPLITUDE (IEG)	WAVE-HEIGHT (M)	SPEED Kts	DIRECTION (DEC)	PRESSURE H-100
180	1.5	6	15	180	1010.3

SUNSHINE		CLOUD		WATER-TEMPERATURE		WIND-TEMPERATURE	
WIND (IEG)	WIND (IEG)	WIND (IEG)	WIND (IEG)	WIND (IEG)	WIND (IEG)	WIND (IEG)	WIND (IEG)
0	0	07	0	0	0	0	0

IMPACT OF OUR WIND AND THE WINDS OF THE

SEE OTHER PAGES

STATION	DATE	TIME Hrs Mins	LAT-E (HRS)	LONG-L (DEC)	TIME ZONE	WIND (IEG)	WIND (IEG)
1000	040378	0639	17.58	105.11	E	15	1010.3
1001	040378	0640	17.58	105.11	E	15	1010.3
1002	040378	0641	17.58	105.11	E	15	1010.3
1003	040378	0642	17.58	105.11	E	15	1010.3
1004	040378	0643	17.58	105.11	E	15	1010.3
1005	040378	0644	17.58	105.11	E	15	1010.3
1006	040378	0645	17.58	105.11	E	15	1010.3
1007	040378	0646	17.58	105.11	E	15	1010.3
1008	040378	0647	17.58	105.11	E	15	1010.3
1009	040378	0648	17.58	105.11	E	15	1010.3
1010	040378	0649	17.58	105.11	E	15	1010.3
1011	040378	0650	17.58	105.11	E	15	1010.3
1012	040378	0651	17.58	105.11	E	15	1010.3
1013	040378	0652	17.58	105.11	E	15	1010.3
1014	040378	0653	17.58	105.11	E	15	1010.3
1015	040378	0654	17.58	105.11	E	15	1010.3
1016	040378	0655	17.58	105.11	E	15	1010.3
1017	040378	0656	17.58	105.11	E	15	1010.3
1018	040378	0657	17.58	105.11	E	15	1010.3
1019	040378	0658	17.58	105.11	E	15	1010.3
1020	040378	0659	17.58	105.11	E	15	1010.3

LENGTH (M)	MAGNESIUM PPM	BORON PPM	COPPER PPM	LEAD PPM	CADMIUM PPM	ZINC PPM	IRON PPM
1000	1276	4.61	0.91	0.73	0.06	0	0
1200	1281	4.61	0.36	0.37	0.06	0	0
1500	1268	4.68	0.64	0.55	0.01	1.59	0
1700	1284	4.65	1.77	1.97	0.07	3.49	0
2000	1279	4.66	0.79	2.15	0.63	0	0
2500	1277	4.64	0.23	0.21	0.03	0	0
3000	1279	4.64	0.48	1.82	0.86	2.03	0
3500	1276	4.66	0.7	0.27	0.04	0	0
4000	0	0	0	0	0	0	0

LENGTH (M)	PO4-P PPM	TU-P PPM	NO3-N PPM	NO2+NO3 PPM	PO4-N PPM	NH4-N PPM	CHLOROPHYLL PPM
1000	0	0	1.7	8.64	6.94	0	0
1200	2.72	0	0	0	0	0	0
1500	2.46	0	2.50	29.8	27.23	0	11.76
1700	2.89	0	1.47	17.57	16.1	0	60.75
2000	2.07	0	0	0	0	0.08	11.07
2500	2.77	0	1.74	13.71	11.87	0	10.3
3000	2.30	0	1.27	23.73	22.13	0	12.86
3500	2.22	0	2.51	24.86	27.49	0	62.83

STATION	DATE	TIRE	LOW-S	LOW-S	TIME-ZONE
DEPT	DEPT	HPS	(DEG)	(DEG)	DEPT
E1	050378	0608	13.19	104.57	N

WIRE-ANGLE (DEG)	NET-RELEASE	RECOVERY-START	NET-SWLS	DET-SWLS	SEA-TYP	SONIC-DEPTH
(DEG)	(DEG)	(DEG)	DEG-C	DEG-C	DEG-C	(M)
0635	0645	73.8	28.0	0		410

SUELL	WIND	WAVE-DETHC	WAVE	DIRECTION	PRESSURE
(DEG)	(DEG)	(M)	(M)	(DEG)	8-84
0	0	0	07	184	1007.4

WHITE	BLACK	CLOUD	WATER-COLOR	WATER-COLOR
(M)	(M)	(M)	(M)	(M)
0	0	02	0	001

*WATER COLOR (M) 1-1000 1000 1000

1000 1000 1000

WAVE	WAVE	WAVE	WAVE	WAVE	WAVE	WAVE	WAVE
(M)	(M)	(M)	(M)	(M)	(M)	(M)	(M)
20	19	28.271	24.739	19.211	4.41	4.18	2.41
40	44	24.412	34.771	19.212	4.78	4.18	2.42
60	68	23.448	34.002	19.333	4.45	4.14	2.34
80	83	19.344	31.344	19.347	4.17	4.17	2.35
100	114	11.170	77.674	19.312	4	4.14	2.37
120	127	11.094	74.714	19.314	4.50	4.13	2.37
140	141	8.107	74.007	19.277	4.31	4.14	2.37
160	149	7.720	71.014	19.170	4.00	4.07	2.4
180	126	4.401	71.112	19.174	4.00	4.04	2.41

LENGTH (M)	MAGNESIUM PPM	BORON PPM	COPPER PPM	LEAD PPM	CADMIUM PPM	ZINC PPM	IRON PPM
20	1262	4.61	0.53	1.66	0.03	0.79	0
50	1254	4.59	0.71	0.18	0.05	2.26	0
100	1267	4.50	0.6	1.1	0.02	0.95	0
150	1258	4.61	0.45	0.72	0.01	1.6	0
200	1279	4.64	0.22	0.1	0.01	2.43	0
300	1264	4.52	1.3	0.00	0.03	1.35	0
400	1245	4.59	1.01	0.25	0.04	0.62	0
600	1248	4.52	0.27	0.25	0.03	0.42	0
800	1254	4.54	0.95	0.71	0.05	1.23	0

LENGTH (M)	MAGNESIUM PPM	BORON PPM	COPPER PPM	LEAD PPM	CADMIUM PPM	ZINC PPM	IRON PPM
20	1270	0	0.25	3.1	2.60	3.07	35.19
50	1271	0	0	0	0	1.29	7.36
100	1270	0	0	0	0	0	0.80
150	1270	0	0.15	11.07	0.01	1.16	0
200	1271	0	0	0	0	0	27.83
250	1272	0	0	0	0	0.55	38.71
300	1272	0	0.15	0.15	0.11	0.00	17.45
400	1270	0	0.27	11.17	18.03	0	61.71
500	1260	0	0	0	0	0	32.52

STATION	DATE	TIME	LAT-E	LONG-S	TIDE-ZONE
####	####	####	(DEG)	(DEG)	####

E2	030378	0800	13.17	104.37	8
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WIRE-ANGLE (DEG)		WET-BUILD		SEA-TEMP		SAND-DEPTH	
WESBERGER-RELEASE (DEG)	RECOVERY-START (DEG)	DEG-C	DEG-C	DEG-C	DEG-C	(M)	####
1010	1040	25.8	28.8	28.7		6100	

SWELL		WIND		PRESSURE	
DIRECTION (DEG)	AMPLITUDE (M)	WAVE-HEIGHT (M)	SPEED Kts	DIRECTION (DEG)	M-PA2
0	0	.6	7	190	1009.4

SECCHI		CLOUD		WATER-COLOR		SARIN-A-COMM	
WHITE (M)	BLACK (M)	(10/100)		100		COMBINED	
0	0	42		0		361	

"WATCH COLOR UNITS ARE 1- FOMEL SCALE P1-P11"

"WLE SCALE P1-P11"

STATION	DATE	TIME	LAT-E	LONG-S	TIDE-ZONE	WAVE-HEIGHT	WIND
####	####	####	(DEG)	(DEG)	####	(M)	(Kts)
1010	030	5.324	24.638	17.173	3.01	7.61	2.44
1020	1104	4.713	34.637	19.172	3.25	7.63	2.66
1030	1424	3.975	34.613	19.204	3.63	7.67	2.12
1040	1811	3.558	24.715	19.216	3.94	7.87	2.42
1050	1701	2.786	34.713	19.226	4.33	7.89	2.41
1100	2111	2.456	34.717	19.225	5.03	7.91	2.43
1110	2403	2.011	34.703	19.227	5.49	7.92	2.45
1120	2305	1.727	34.727	19.225	5.65	7.91	2.38
1130	3041	1.59	34.723	19.222	6.2	7.91	2.33
1140	0	0	34.723	19.22	0	0	0

DATE: 10/1/68

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STATION	DATE	TIME	LAT-C (DEG)	LONG-S (DEG)	TIME-ZONE
XXXX	XXXX	XXXX	XXXX	XXXX	XX XX XX
E2	050378	0800	13.19	184.39	W

WIND-MOULE (DEG)					
WIND SPEED					
WIND-REL-SE	RECOVER-START	WET-BULB	DRY-BULB	SEA-TEMP	SINIC-DEPTH
(DEG)	(DEG)	DEG-C	DEG-C	DEG-C	(M)
RECOVER-START	RECOVER-START	RECOVER-START	RECOVER-START	RECOVER-START	RECOVER-START
1010	1040	25.8	28.8	28.7	6100

SWELL		WIND		PRESSURE	
WAVE		WAVE		WAVE	
DIRECTION	AMPLITUDE	WAVE-HEIGHT	SPEED	DIRECTION	PRESSURE
(DEG)	(M)	(M)	Kts	(DEG)	IN-HG
RECOVER-START	RECOVER-START	RECOVER-START	RECOVER-START	RECOVER-START	RECOVER-START
0	0	.A	7	190	1607.4

BEGING		WATER-TEMP		WIND-TEMP	
WAVE		WAVE		WAVE	
WAVE	WAVE	WAVE	WAVE	WAVE	WAVE
(DEG)	(DEG)	(DEG)	(DEG)	(DEG)	(DEG)
RECOVER-START	RECOVER-START	RECOVER-START	RECOVER-START	RECOVER-START	RECOVER-START
0	0	02	0	161	

WIND-TEMP-START ARE IN DEGREE F-100

USE SCALE 0-100

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WAVE	DEPTH	TEMP	SALT	CHLOR	DENSITY	WAVE	TEMP-210
(DEG)	(M)	(DEG)	(DEG)	(DEG)	(DEG)	(DEG)	(DEG)
RECOVER-START	RECOVER-START	RECOVER-START	RECOVER-START	RECOVER-START	RECOVER-START	RECOVER-START	RECOVER-START
1010	1020	2.320	24.238	19.174	3.01	7.81	2.34
1010	1020	4.015	24.637	19.173	3.25	7.83	2.61
1010	1024	3.926	24.693	19.284	3.63	7.87	2.82
1010	1018	2.576	24.713	19.214	3.94	7.87	2.62
1010	1020	2.554	24.733	19.224	4.33	7.89	2.41
1010	1020	2.561	24.727	19.225	5.02	7.91	2.40
1010	1018	2.011	24.733	19.127	5.45	7.92	2.42
1010	1018	1.777	24.727	19.127	5.85	7.91	2.40
1010	1018	1.255	24.722	19.122	6.2	7.91	2.37
1010	0	0	24.722	19.122	6	8	0

LENGTH (IN)	MAGNESIUM PPH	IRON PPH	COPPER PPH	LEAD PPH	ZINC PPH	ZINC PPH	IRON PPH
1000	1263	4.65	0.95	0.41	0.03	0.57	0
1200	1272	4.65	1	0.99	0.04	0.87	0
1300	1268	4.61	0	0	0.11	0	0
1700	1278	4.65	0.79	0.42	0.03	2.8	0
2000	1277	4.63	1.38	0.37	0.05	2.24	0
2500	1277	4.65	0.67	0.67	0.03	0.9	0
3000	1274	4.59	0.18	0	0.03	3.08	0
3500	1267	4.61	1.65	0.5	0.1	0.6	0
4000	1260	4.6	0.44	0.38	0.03	1	0
4000	1237	0	0.77	0.68	0.02	1.25	0

LENGTH (IN)	PER-1 PPH	PER-2 PPH	PER-3 PPH	PER-4 PPH	PER-5 PPH	PER-6 PPH	PER-7 PPH
1000	2.29	0	0	0	0	0.58	52.27
1200	2.97	0	1.28	18.43	17.15	1.42	51.59
1300	3.15	0	0	0	0	0	41.94
1700	1.61	0	0.85	17.67	16.82	0.41	51.08
2000	2.49	0	0.75	15.55	14.8	0	74.19
2500	3.01	0	1.03	16.18	14.55	0	41.56
3000	1.81	0	2.07	14.04	11.75	0.67	41.21
3500	2.52	0	2.11	17.22	11.21	0	35.81
4000	2.67	0	2.05	21.91	19.56	0	78.11

STATION	DATE	TIME	LAT-E (DEG)	LONG-B (DEG)	TIRE-ZONE
FT	060378	0815	09.01	104.90	H
WIRE-ANGLE (DEG)					
MEMBER-RELEASE RECOVERY-START (DEG)					
0825	0855	26.5	29.0	21.2	3618
WIND					
DIRECTION (DEG)	AMPLITUDE (M)	WAVE-HEIGHT (M)	WIND KTS	DIRECTION (DEG)	PRESSURE IN-BAR
010	00	0	10	310	1010
SUN					
WIND	SLASH (M)	CLOUD (10/100)	WATER-TEMP C	WIND-TEMP C	
0	0	07	0	229	

WIND DIRECTION DATA ARE IN DEGREE SCALE FT-FT

WIND SCALE WIND-UNIT

DEPTH (M)	TEMP (C)	TEMP (F)	COND (G)	COND (G)	COND (G)	COND (G)	COND (G)
20	21	29.242	34.525	19.111	1.5	8.13	2.25
50	48	25.644	34.562	19.131	2.2	8.15	2.29
100	91	19.323	34.577	19.117	2.52	7.97	2.29
150	130	15.178	34.57	19.138	0	7.97	2.31
200	105	12.279	34.624	19.164	7.1	7.15	2.33
300	250	10.137	34.601	19.264	2.67	7.8	2.19
400	378	10.152	34.587	19.295	2.8	7.31	2.41
600	570	8.398	34.777	19.25	2.37	7.76	2.42
600	747	6.75	34.697	19.266	2.54	7.77	2.44

LENGTH (M) METER	MAGNESIUM PPM PPM	BORON PPM PPM	COPPER PPM PPM	LEAD PPM PPM	CADMIUM PPM PPM	ZINC PPM PPM	IRON PPM PPM
20	1248	4.61	1.97	0.83	0.03	0.60	0
30	1259	4.6	1.27	4.29	0.04	0.76	0
100	1234	4.6	0.74	0.85	0.04	1.47	0
150	1240	4.57	6.237	2.1	0.03	0.72	0
200	1276	4.59	2.03	0	0.03	1.31	0
300	1282	4.59	1.32	1.09	0.03	3.49	0
400	1275	4.62	0.76	0.81	0.09	1.22	0
600	1273	4.62	0.6	0.71	0.03	1.41	0
800	1234	4.57	1.21	0.65	0.03	1.08	0

101037A-101 METER	101-P METER	101-P METER	102-H METER	102-H-3 METER	102-H METER	102-H METER	102-H-1 METER
20	0	0	0.9	11.38	10.48	3.3	4.69
30	0	0	0.92	1.83	0.91	1.01	0
100	1.35	0	0	0	0	1.52	34.87
150	0.77	0	0	0	0	0	28.47
200	1.76	0	4.50	16.63	12.04	0	0
400	2.22	0	0	0	0	0.64	12.57
600	1.71	0	1.70	25.68	23.3	1.4	37.9
800	2.07	0	1.67	13.47	11.8	1.97	64.22

STATION DATA	DATE DATA	TIME HRS DATA	LAT-E (DEG) DATA	LONG-S (DEG) DATA	TIME-ZONE DATA, DATA
F2	060378	0815	09.01	104.58	1
WIRE-ANGLE (DEG) DATA DATA					
PASSENGER-RELEASE (DEG) DATA DATA	RECOVERY-START (DEG) DATA DATA	SET-UP/LD Deg-C DATA DATA	DRY-FIELD Deg-C DATA DATA	SEA-TEMP Deg-C DATA DATA	SONIC-DEPTH (M) DATA DATA
1020	1045	24.5	29.0	29.2	5661
SWELL DATA DATA					
DIRECTION (DEG) DATA DATA	AMPLITUDE (M) DATA DATA	WAVE-HEIGHT (M) DATA DATA	SPEED Kts DATA DATA	DIRECTION (DEG) DATA DATA	PRESSURE H-BAR DATA DATA
010	00	0	10	310	1010
WIND DATA DATA					
WATER-COLOR DATA DATA					
MARSEN-BUREAU DATA DATA					
0	0	07	0	310	

WATER COLOR UNITS ARE 1/1000 SCALE 01-1000

WAVE SCALE 01-1000

TEMP (C) DATA	TEMP (C) DATA	TEMP (C) DATA	SALIN PPT DATA	WIND PPT DATA	WIND Kts DATA	WIND Kts DATA	WIND Kts DATA
1000	1010	5.659	34.691	19.203	2.7	7.01	2.45
1200	1175	4.737	34.779	19.251	3.10	7.0	2.41
1400	1140	4.05	34.808	19.267	3.48	7.0	2.45
1600	1036	3.409	34.755	19.24	2.22	7.04	2.52
1800	1034	2.937	34.710	19.242	4.40	7.07	2.53
2000	1036	2.311	34.741	19.23	5.02	7.57	2.54
2200	2510	1.76	34.727	19.238	5.56	7.57	2.43
2400	2512	1.674	34.752	19.234	5.05	7.51	2.47
2600	3004	1.423	34.724	19.221	7.7	7.60	2.38

LENGTH (IN)	MAGNESIUM PPH	SODIUM PPH	COPPER PPB	LEAD PPB	CADMIUM PPB	ZINC PPB	IRON PPB
1000	1188	4.59	0.7	1.69	0.05	1.19	0
1200	1191	4.57	2.2	1.74	0.03	1.21	0
1500	1272	4.58	2.3	1.98	0.03	0.98	0
1700	1187	4.62	0.37	0.42	0.08	0.61	0
2000	1193	4.66	0	0	0.02	0.42	0
2500	1223	4.60	0	1.7	0.05	0.69	0
3000	1224	4.64	0.12	0.18	0.01	1.06	0
3300	1219	4.61	0.55	0.55	0.08	0.77	0
4000	1259	4.59	1.84	0.78	0.05	0.66	0
4030	0	0	2.15	0	0.01	0.5	0

LENGTH (IN)	100-PPH	100-PPH	100-PPH	NOTIFIED PPH	100-PPH	100-PPH	100-PPH
1000	0	0	0	0	0	0	45.1
1200	3.42	0	0	22.54	20.54	0	57.84
1500	1.44	0	1.32	22.01	24.57	0	14.94
1700	5.04	0	0	0	0	0	45.1
2000	2.1	0	2.73	14.19	11.66	0.65	51.30
2300	2.18	0	1.3	17.05	15.79	0	0
3000	2.61	0	0	0	0	0	72.03
3300	2.15	0	2.11	17.80	14.77	0	50.11
4000	2.07	0	2.11	10.6	8.41	0	6.82
4030	0	0	0	0	0	0	0

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LENGTH (IN)	MAGNESIUM PPH	BORON PPH	COPPER PPH	LEAD PPH	CADMIUM PPH	ZINC PPH	IRON PPH
20	1175	4.21	0	0	0	0	0
50	1272	4.57	0.41	0.66	0.05	0.83	0
100	1153	4.6	0	0	0	0	0
150	1163	4.58	0	0	0	0	0
200	1227	4.62	0.71	0.66	0.03	3.14	0
300	1240	4.63	0	0	0	0	0
400	1166	4.1	0.55	0.41	0.03	0.45	0
500	1197	4.73	0	0	0	0	0
600	1211	4.62	1.01	0.65	0.01	1.18	0
1000	1235	4.65	0	0	0	0	0

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LENGTH (IN)	COBALT PPH	TOBACCO PPH	MOBIL PPH	MOBILE PPH	MOBIL PPH	MOBIL PPH	MOBIL PPH
20	0.24	0	0	0	0	0	3.77
50	0.2	0	0.20	0.17	3.89	0	4.76
100	0.47	0	0.47	7.12	6.65	2.16	12.94
150	0.33	0	0	0	0	1.55	2.15
200	0.24	0	0	0	0	0.65	3.2
300	1.14	0	0	0	0	1.41	27.11
400	2.35	0	0	0	0	0.75	38.29
500	0.96	0	0	0	0	0	71.11
600	1.45	0	1.16	0.04	2.60	0	70.74
1000	2.77	0	4.01	21.73	17.72	0	51.02

NOTE: ALL CONCENTRATIONS ARE IN PPM PER LITER

STATION	DATE	TIME Hrs Min	LAT-L (DEG) TIME	LONG-L (DEG) TIME	TIME-ZONE
62	070370	1025	10.15	110.00	H
WIRE-ANGLE (DEG) DATA WIRE					
MESSENGER-RELEASE (DEG)	RECOVERY-START (DEG)	WET-BULB Deg-C	DRY-BULB Deg-C	SEA-TEMP Deg-C	SONIC-HEIGHT (M)
1225	1250	24.7	29.8	28.1	7708
SWELL					
DIRECTION (DEG)	AMPLITUDE (M)	WAVE-HEIGHT (M)	SPEED Kts	DIRECTION (DEG)	PRESSURE M-BAR
115	02	12501.0	17	053	1010.0
SICCHI					
WHITE (M)	BLACK (M)	CLOUD (10ths)	WATER-COOLING	BARBER-COOLING	
0	0	07	0	725	

1950-51 Actual 1950-51	1951-52 (1) 1951-52	1952-53 (2) 1952-53	1953-54 (3) 1953-54	1954-55 (4) 1954-55	1955-56 (5) 1955-56	1956-57 (6) 1956-57	1957-58 (7) 1957-58
10.02	10.43	4.874	34.687	19.12	3.12	2.79	1.73
15.64	13.29	4.027	34.716	19.217	3.11	2.60	2.50
17.69	14.50	3.76	34.731	19.241	3.09	2.54	2.36
19.90	15.65	3.249	34.76	19.241	3.10	2.50	2.33
21.13	20.16	2.686	34.773	19.241	3.09	2.46	2.26
22.00	27.03	2.694	34.773	19.222	3.26	2.29	2.24
23.10	21.13	1.785	34.773	19.222	3.26	2.09	2.20
24.12	23.60	1.663	34.773	19.211	3	2.01	2.14
25.30	0	0	0	0	2.1	0	0

LENGTH (K)	MAGNETIC FIELD (GAUSS)	SCATTER INDEX (K)	ORDER INDEX (K)	LEAD INDEX (K)	CASIMIR INDEX (K)	ZERO INDEX (K)	TRIP INDEX (K)
1200	1212	4.04	0	0	0	0	0
1200	1244	4.04	0.04	0.05	0.02	0	0
1200	1221	4.04	0	0	0	0	0
1200	1212	4.04	0	0	0	0	0
1200	1247	4.04	0.04	0.03	0.03	1.21	0
1200	1237	4.04	0	0	0	0	0
1200	0	4.04	0	0	0	0	0
1200	1224	0	0.20	0.45	0.03	0.21	0

1200	1212	4.04	0	0	0	0	0
1200	1244	4.04	0.04	0.05	0.02	0	0
1200	1221	4.04	0	0	0	0	0
1200	1212	4.04	0	0	0	0	0
1200	1247	4.04	0.04	0.03	0.03	1.21	0
1200	1237	4.04	0	0	0	0	0
1200	0	4.04	0	0	0	0	0
1200	1224	0	0.20	0.45	0.03	0.21	0

STATION 0000	DATE 0000	TIME Hrs 0000	LAT-E (DEG) 00.00	LONG-S (DEG) 00.00	TIME-ZONE 0000 0000
M1	080376	1200	14.40	112.00	H
WIRE-ANGLE (DEG) 0000 0000					
RESEADER-RELEASE (DEG) 000000 000000	RECOVERY-START (DEG) 000000 000000	NET-BUILD Deg-C 000000	DRI-BUILD Deg-C 000000	SEA-TEMP Deg-C 000000	SONIC-DEPTH (M) 0000 0000
1210	1240	26.7	30.7	28.9	4416
SWELL 0000					
DIRECTION (DEG) 000000	AMPLITUDE (M) 000000	PERIOD-HEIGHT (M) 000000	SPEED Kts 0000	DIRECTION (DEG) 000000	PRESSURE M-TAR 000000
140	1	1.5	15	110	1809.9
SECCAL 0000					
WHITE (K) 0000	BLACK (K) 0000	BLOND (10/Lbs) 0000	WATER-COLOR 000 000000	HARDEN-SQUARE 000000 0000	
03.6	20.0	C2	F-1	360	

*WATER COLOR UNITS ARE 1- FORD SCALE P1-P11

WLE SCALE U1-U11"

DEPTH (M) 0000	TEMP (C) 00.00	SALTE PPT 0000	CELR PPT 0000	OXYGEN PPM 0000	pH 00.00	TAT-H2O CE-L 0000
20	16	28.41	34.684	19.199	6.9	8.16
40	16	27.701	34.578	19.14	6.85	8.2
60	16	25.713	34.546	19.345	6.84	8.21
80	16	21.332	35.192	19.483	6.27	8.15
100	16	16.033	34.615	19.298	4.02	7.90
120	16	11.494	34.720	19.223	3.43	7.91
140	16	10.449	34.92	19.20	3.64	7.91
160	16	8.002	34.701	19.205	4.43	7.63
180	16	6.06	34.64	19.174	3.51	7.74
200	16	5.33	34.621	19.164	3.01	7.76

LENGTH (IN)	MAGNESIUM PPH	BORON PPH	COPPER PPH	LEAD PPH	CADMIUM PPH	ZINC PPH	IRON PPH
20	1223	4.69	0	0	0	0	0
50	1218	4.63	0.75	0.42	0.02	1.95	0
100	1229	4.73	0	0	0	0	0
150	1266	4.74	0	0	0	0	0
200	1235	4.64	0.3	0.2	0.02	1.04	0
300	1268	4.6	0	0	0	0	0
400	1216	4.63	0.21	0.24	0.03	2.84	0
600	1229	4.6	0	0	0	0	0
800	1254	4.65	1.65	0.26	0.83	1.05	0
1000	1248	4.68	0	0	0	0	0

LENGTH (IN)	PPH-7	PPH-4	PPH-8	PPH-10	PPH-12	PPH-15	PPH-20
20	0.30	0	0.65	0.65	1.01	0	0.41
50	0.07	0	0.43	0.2	2.05	1.15	0.52
100	0.42	0	0	4.54	4.54	1.24	4.41
150	0.54	0	0	0	0	1.25	5.14
200	1.41	0	0	0	0	1.97	10.53
300	2.10	0	0.84	12.00	12.57	1.15	74.75
400	2.31	0	0	0	0	0	27.01
600	2.17	0	1.10	12.40	12.04	0	71.84
800	1.24	0	0	0	0	0.23	40.34
1000	0	0	2.10	11.89	21.21	0	0

LENGTH (ft) DEPTH	NADIR SURF FEET DEPTH	BORON PPM DEPTH	COPPER PPM DEPTH	LEAD PPM DEPTH	CHROMIUM PPM DEPTH	ZINC PPM DEPTH	IRON PPM DEPTH
1200	1273	4.64	0	0	0	0	0
1500	1313	4.68	0.23	0.16	0.03	1.43	0
1700	1286	4.6	0	0	0	0	0
2000	1243	4.62	0	0	0	0	0
2500	1240	4.61	0.57	0.47	0.03	3.79	0
3000	1267	4.6	0.74	0.83	0.03	0.6	0
3500	1216	4.58	0	0	0	0	0
4000	1253	4.57	0.28	0.1	0.02	0.76	0
4030	0	0	0	0	0	0	0

LENGTH (ft) DEPTH	BORON PPM DEPTH	COPPER PPM DEPTH	CHROMIUM PPM DEPTH	LEAD PPM DEPTH	CHROMIUM PPM DEPTH	ZINC PPM DEPTH	IRON PPM DEPTH
1200	5.8	0	2.17	13.75	11.08	0	52.27
1500	1.07	0	1.79	10.45	17.07	0.49	0
1700	2.79	0	1.61	20.65	16.44	0	53.8
2000	1.69	0	1.9	16.32	14.43	0.24	36.6
2500	2.16	0	0	0	0	0.22	20.45
3000	0	0	1.38	21.31	19.73	0.17	60.56
3500	2.04	0	1.02	12.95	16.73	0	32.78
4000	1.92	0	2.01	14.04	13.82	0	68.52
4030	0	0	0	0	0	0	0

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STATION	DATE	TIME	LAT E	LONG S	TIME-ZONE
DATA	DATA	Mrs	(DEG)	(DEG)	DATA
J1	090373	1325	19.30	112.00	M

WIRE ANGLE (DEG)		DET-PULL	DRY BULK	SEA-TEMP	SONIC-DEPTH
PASSENGER-RELEASE	RECOVERY-START	Deg-C	Deg-C	Deg-C	(M)
DATA	DATA	DATA	DATA	DATA	DATA
1415	1430	27.5	29.7	29.2	7030

SWELL		WIND		PRESSURE	
DIRECTION	AMPLITUDE	WAVE-HEIGHT	SPEED	DIRECTION	N-BAR
(DEG)	(M)	(M)	KLS	(DEG)	DATA
DATA	DATA	DATA	DATA	DATA	DATA
190	02	.3	02	170	1013.5

SECCHI		CLOUD		WATER-COLOUR		PARADOX-SUBMERG	
UNIT	BLACK	(10/100)	DATA	DATA	DATA	DATA	DATA
(M)	(K)	DATA	DATA	DATA	DATA	DATA	DATA
DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA
0	0	0	0	0	0	160	

*WATER COLOUR DATA ARE IN FOREL SCALE F1-F11

WLR SCALE W1-W11

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WATER	DEPTH	TEMP	SALIN	CHLOR	OXIDIZ	PH	TEMP
(M)	(M)	(C)	(PPT)	(PPT)	(PPT)	(M)	(C)
DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA
20	19	29.107	35.354	19.57	6.41	8.22	2.41
50	49	27.105	35.273	19.525	6.91	8.24	2.31
100	93	22.771	35.144	19.453	6.78	8.22	2.12
200	102	19.110	35.572	19.49	5.09	8.16	2.33
300	201	14.19	35.377	19.562	7.40	8.15	2.33
400	305	10.643	34.976	19.36	5.77	8.12	2.31
600	566	7.315	34.779	19.201	5.83	7.94	2.31
800	708	5.925	34.615	19.172	3.11	7.85	2.13
1000	832	5.325	34.632	19.17	3.3	7.83	2.43

LENGTH (IN) DEPTH	MAGNESIUM PPM DEPTH	BORON PPM DEPTH	COPPER PPB DEPTH	LEAD PPB DEPTH	CADMIUM PPB DEPTH	ZINC PPB DEPTH	IRON PPB DEPTH
20	1302	4.73	0	0	0	0	0
50	1277	4.75	1.30	0.83	0.83	2.01	0
100	1233	4.71	0	0	0	0	0
200	1294	4.76	0.77	0.5	0.03	1.46	0
300	1282	4.72	0	0	0	0	0
400	1246	4.68	1.44	2.77	0.03	1.56	0
600	1263	4.6	0	0	0	0	0
800	1240	4.7	1.20	3.15	0.02	1.02	0
1000	1244	4.62	1.5	0.50	0.03	0	0

LENGTH (IN) DEPTH	PO4-P PPM DEPTH	NO3-N PPM DEPTH	NO2-N PPM DEPTH	NO2+NO3 PPM DEPTH	CL2-B PPM DEPTH	PHOS-P PPM DEPTH	PHOS-SI PPM DEPTH
20	0.4	0	0	0	0	1.2	1.44
50	0.39	0	0	0	0	0.69	2.55
100	0.97	0	0.29	1.01	0.72	0.73	26.83
200	1.0	0	0	0	0	0	20.97
300	0.3	0	0	0	0	0	1.82
400	1.14	0	0	0	0	1.72	2.40
600	1.14	0	1.15	23.14	17.10	1.07	16.50
800	2.8	0	0	0	0	1.87	0
1000	2.72	0	1.0	14.7	12.9	1.0	25.2

STATION	DATE	TIME	LAT E	LONG	TIME-ZONE
XXXX	XXXX	HH	(1950)	(DEG)	XXXX

J2	090370	1325	19.70	112.80	N
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WIDE-ANGLE (DEG)

MESSENGER-RELEASE	RECOVERY-START	NET-DULD	DRY-FLD	SEA-Temp	COND-DEPTH
(DEG)	(DEG)	DEG-C	DEG-C	DEG-C	(M)

1415	1430	27.5	29.7	29.2	2030
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SWELL

DIRECTION	AMPLITUDE	WAVE-HEIGHT	SPEED	DIRECTION	PERCENT
(DEG)	(M)	(M)	Kts	(DEG)	M-FAR

190	02	.3	04	170	1011.5
-----	----	----	----	-----	--------

SEECHE

WHITE	BLACK	CLOUD	WATER-COLOR	WATER-COLOR
(%)	(%)	(10/100)	(10/100)	(10/100)

0	0	0	0	100
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*WATER COLOR UNITS ARE 1/1000 SCALE (1-100)

WAVE SCALE (1-100)

WAVE	WAVE	WAVE	WAVE	WAVE	WAVE	WAVE	WAVE
(10/100)	(10/100)	(10/100)	(10/100)	(10/100)	(10/100)	(10/100)	(10/100)
1100	1040	4.965	34.635	19.172	3.20	7.00	2.41
1000	1140	4.700	34.638	19.173	3.45	7.05	2.92
1000	1440	3.920	34.67	19.151	3.82	7.12	2.43

LENGTH (M) PPPM	MAGNESIUM PPM PPPM	BORON PPM PPPM	COPPER PPB PPPM	LEAD PPB PPPM	CADMIUM PPB PPPM	ZINC PPB PPPM	IRON PPB PPPM
1100	1276	4.50	0	0	0	0	0
1200	1222	4.64	1.6	0.86	0.43	0.42	0
1300	1220	4.67	0	0	0	0	0
1530	0	0	1.17	0.62	0.03	1.08	0

LENGTH (M) PPPM	PHOSPHORUS PPM PPPM	TRIT-P PPM PPPM	PRO-W PPM PPPM	PRO-NC1 PPM PPPM	NO3-W PPM PPPM	NO3-B PPM PPPM	SI02-SI PPM PPPM
1100	1.95	0	3.52	16.08	12.56	0.17	45.49
1200	2.07	0	1.64	22.41	20.77	0	38.03
1500	2.03	0	0.81	20.62	20.01	0	38.45

NOTE: ALL NUTRIENTS ARE MICROGRAMS PER LITER *

STATION NO.	DATE DDMM	TIME Hrs MMSS	LAT-E (DEG) LAT	LONG-S (DEG) LONG	TIME-ZONE TIME DIFF
K	100378	1237	24.00	112.00	8
WIRE-ANGLE (DEG) WIRE ANGLE					
MESSAGE-RELEASE (DEG) MESSAGE RELEASE	RECOVERY-START (DEG) RECOVERY START	WET-GULF Deg C WET GULF	PR1-BALL Deg-C PR1-BALL	WIA-TEMP Deg-C WIA-TEMP	WIND-DEPTH (M) WIND DEPTH
1250	1320	27.0	27.0	25.6	960
SWELL SWELL					
DIRECTION (DEG) DIRECTION	AMPLITUDE (M) AMPLITUDE	WAVE-HEIGHT (M) WAVE-HEIGHT	SPEED Kts SPEED	DIRECTION (DEG) DIRECTION	PRESSURE h-Pa PRESSURE
180	04	2.0	28	185	1015.2
SECCHI SECCHI					
WHITE ft) WHITE	BLACK (ft) BLACK	CLOUD (10/100) CLOUD	WATER-COLOR WATER COLOR	WATER-TEMP WATER TEMP	WIND-TEMP WIND TEMP
0	0	01	0		392

*WATER COLOR UNITS ARE 1- FOGEL SCALE F1-F11

WIND SCALE 01-111

DEPTH (M) DEPTH	DEPTH (F) DEPTH	TEMP (C) TEMP	SALIN PPT SALIN	WIND DPT WIND	WIND DPT WIND	WIND DPT WIND	WIND DPT WIND
20	10	26.467	35.433	19.613	6.73	0.23	2.2
50	45	22.702	35.657	19.76	7.17	0.24	2.33
100	91	20.205	35.773	19.607	7.31	0.23	2.77
150	137	19.077	35.592	19.696	6.17	0.2	2.27
200	183	16.913	35.715	19.781	7.35	0.22	2.77
300	276	17.174	35.251	19.571	7.06	0.18	2.75
400	370	18.728	34.89	19.607	6.13	0.15	2.57
500	520	8.520	34.626	19.167	7.25	0.04	2.31
600	732	8.516	34.335	19.113	4.59	2.19	2.07

LENGTH (ft) DEPTH	MAGNESIUM PPM DEPTH	BORON PPM DEPTH	COPPER PPM DEPTH	LEAD PPM DEPTH	CADMIUM PPM DEPTH	ZINC PPM DEPTH	IRON PPM DEPTH
20	1224	4.81	0	0	0	0	0
50	1227	4.85	0.16	0.35	0.04	1.57	0
100	1259	4.89	0	0	0	0	0
150	1291	4.84	0.09	0.17	0.03	0.35	0
200	1198	4.86	0.05	0.32	0.03	2.88	0
300	1186	4.83	0	0	0	0	0
400	1145	4.76	0.70	0.75	0.06	0	0
600	1163	4.73	0	0	0	0	0
800	1166	4.65	0	0	0	0	0
850	0	0	1.66	9.55	0.93	2.82	0

LENGTH (ft) DEPTH	FRANK PPM	TOTAL PPM	NICKEL PPM	NICKEL PPM	NICKEL PPM	NICKEL PPM	NICKEL PPM
20	0.73	0	0.53	1.17	0.66	0.23	2.06
50	0.53	0	0	0	0	0.11	0.8
100	0.81	0	0.06	1.23	1.17	0.11	4.44
150	1.08	0	0	0	0	0.43	8.24
200	0.76	0	0	0	0	0	3.24
300	0.14	0	0	0	0	0	0.19
400	0.99	0	0.05	10.05	9.67	0	0
600	1.05	0	0.9	2.4	1.5	1.13	30.67
800	3.03	0	3.76	13.51	9.75	0.69	42.91

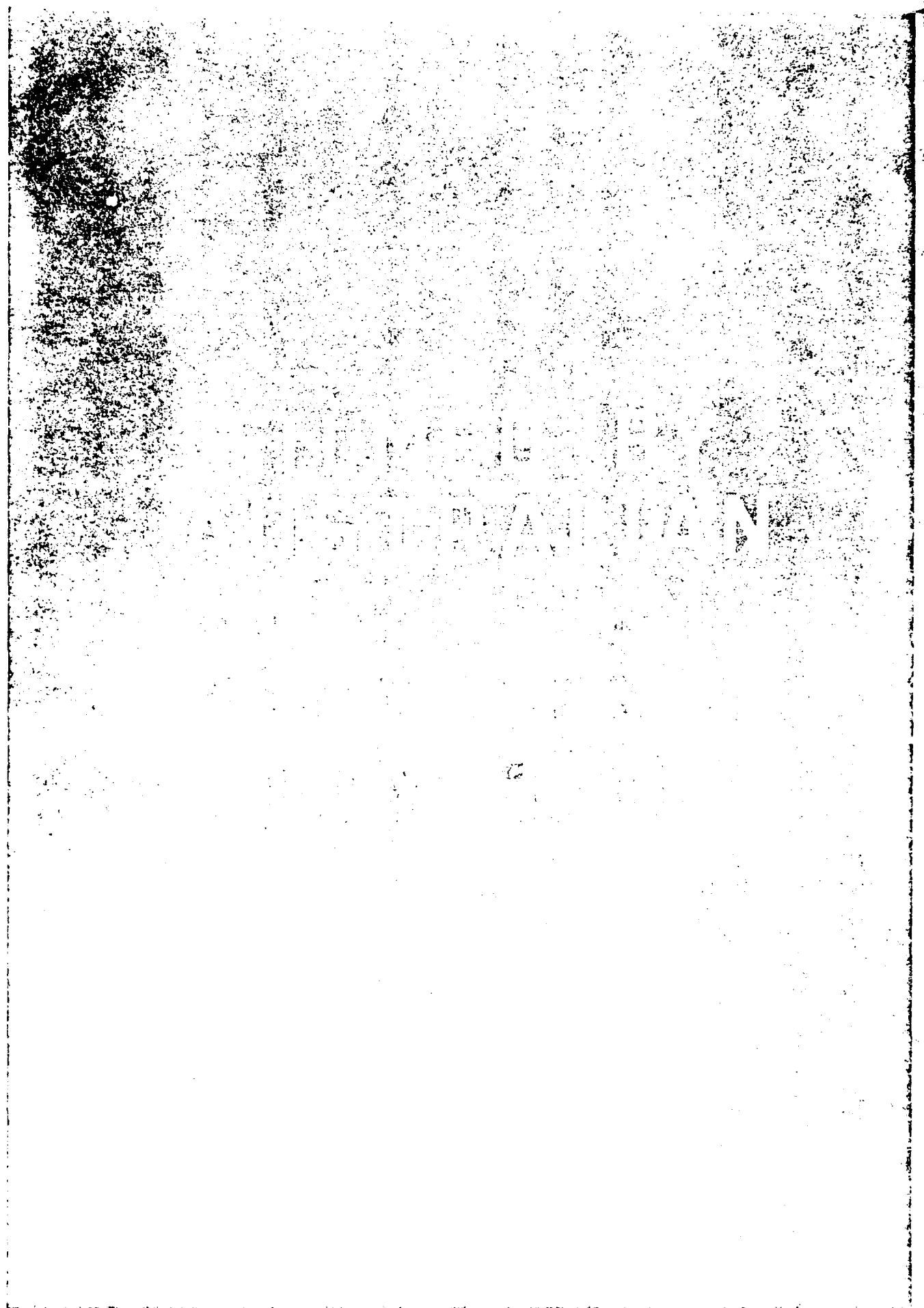
STATION XXXX	DATE YYYY	TIME Hrs MMSS	LAT-E (DEG) XXXX	LONG-S (DEG) XXXX	TIME-ZONE XXXX
L	110379	1325	29.60	113.31	H
WIRE-ANGLE (DEG) XXXX					
RECEIVER-RELAY RECOVERY-START (DEG) XXXXXXXX	RECOVERY-START (DEG) XXXXXX	NET-BUILD Deg-C XXXXXXXX	SPY-BUILD Deg-C XXXXXXXX	SFA-TEMP Deg-C XXXXXX	SOUND-DEPTH (ft) XXXXXX
1400	1410	17.0	21.0	25.0	1112
SHELL XXXX		FINS XXXX			
DIRECTION (DEG) XXXXXXXX	AMPLITUDE (ft) XXXXXXXX	WAVE-DEPTH (ft) XXXXXXXX	STEEP ALL XXXXXX	DIRECTION (DEG) XXXXXXXX	PRESSURE H-54X XXXXXX
120	05	1.3	20	160	101A.7
SOUND XXXX					
WHITE (ft) XXXX	BLACK (ft) XXXX	CLOUD (100/100) XXXX	WATER-COLOR XXXX	THUNDER-SOUND XXXXXX	
0	0	02	0	395	

"H-54X COLOR M-100 AND H-54X SCALE 10-100" "H-54X SCALE 10-100"

DEPTH (ft) XXXX	DEPTH (ft) XXXX	TEMP (F) XXXX	TEMP (F) XXXX	TEMP (F) XXXX	TEMP (F) XXXX	TEMP (F) XXXX	TEMP (F) XXXX
70	18	24.272	35.704	19.763	7.04	0	4
85	40	23.841	35.664	19.741	6.99	3	0
100	60	23.276	35.701	19.666	7.40	4	0
115	100	19.479	35.701	19.789	7.40	0	0
130	125	15.97	35.636	19.726	7.46	0	4
145	145	13.57	35.304	19.340	7.7	0	3
160	160	10.90	34.512	19.323	7.10	4	3
175	185	8.84	24.651	19.101	7.64	4	0
190	230	5.724	34.34	19.041	6.40	0	0

LENGTH (IN)	MAGNESIUM PPM	BARON PPM	COPPER PPM	LEAD PPM	CADMIUM PPM	ZINC PPM	IRON PPM
20	1102	4.8	0.42	0.42	0.63	3	0
50	1187	4.82	1	0.28	0.63	4.5	0
100	1191	4.8	0	0	0	0	0
150	1187	4.82	0	0	0	0	0
200	1191	4.8	0.55	0.30	0.01	1.99	0
300	1176	4.8	0	0	0	0	0
400	1164	4.72	1.5	0.51	0.01	0.53	0
600	1158	1.04	0	0	0	0	0
800	1156	4.45	0.70	0.50	0.03	0.54	0
850	0	0	1.42	0.63	0.03	2.07	0

LENGTH (IN)	MAGNESIUM PPM	BARON PPM	COPPER PPM	LEAD PPM	CADMIUM PPM	ZINC PPM	IRON PPM
100	0.10	0	0.27	1.94	1.24	0	1.10
200	0.10	0	0.50	0.63	0.01	0.28	2.07
300	0.10	0	0.01	1.47	0.10	1.02	10.00
400	0.10	0	0	0	0	0	0.10
500	0.10	0	0	0	0	0	0
600	0.10	0	0	0	0	0	0.10
700	0.10	0	0.04	0.7	4.21	0.07	0.10
800	0.10	0			0	0.10	0.10
900	1.44	0	0.41	10.50	10.12	0	0.10



DATE
ILME